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ABSTRACT

Intended as a framework for analysis of the costs and benefits of developing an operational educational satellite system in the United States, this memorandum presents a series of scenarios of potential applications together with alternative organizational arrangements to support them. The number of satellite channels (25) and the number of ground terminals (up to 50,000-70,000) that might be required to serve various educational sectors are estimated. The market scenarios described include (1) public broadcasting; (2) early childhood education; (3) elementary and secondary education; (4) career and vocational/technical education; (5) adult education; (6) higher education; (7) special education including migrants, correctional institutions and the handicapped; and (8) computer and information services. Alternative administrative frameworks included for illustrative purposes are (1) Project Out-Reach; (2) Educational Satellite Consortium (EDSAC)-both of which are already in operation--together with (3) SKYNET, a proposed commercial satellite system to serve users in and out of education; and (4) PILOT, a government owned and operated system that would provide bulk quantities of satellite channel time to private sector telecommunications organizations. (DGC)

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April, 1975

MARKET SCENARIOS AND ALTERNATIVE ADMINISTRATIVE FRAMEWORKS FOR U.S. EDUCATIONAL SATELLITE SYSTEMS

by

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2/3

TABLE OF CONTENTS

No. Page

1. Introduction and Summary . . . 1

1.1 Market Scenarios . . . 2

1.1.1 Public Broadcasting . . . 2
1.1.2 Early Childhood Education . . . 3
1.1.3 Elementary and Secondary Education . . . 3
1.1.4 Career and Vocational/Technical Education . . . 4
1.1.5 Adult Education . . . 5
1.1.6 Higher Education . . . 5
1.1.7 Special Educational Markets . . . 6
1.1.8 Computer and Information Services . . . 8
1.1.9 Comment . . . 10

1.2 Alternative Administrative Frameworks . . . 10

1.2.1 "Project Out-Reach" . . . 10
1.2.2 EDSAC (Educational Satellite Consortium) . . . 11
1.2.3 SKYNET . . . 12
1.2.4 PILOT . . . 12

1.3 Overview . . . 13

2. Market Scenarios . . . 15

2.1 Introduction . . . 15

2.2 Public Broadcasting . . . 18

2.2.1 Near-Term Requirements . . . 19
2.2.2 Long-Term Requirements . . . 21

2.3 Early Childhood Education . . . 28

2.3.1 Delivery Points . . . 34

2.4 Elementary and Secondary Education . . . 35

2.4.1 Open Education . . . 40
2.4.2 Delivery Points . . . 43
2.4.3 Summary of Channel and Delivery Point Requirements . . . 45

2.5 Career and Vocational/Technical Education . . . 45

2.5.1 Delivery Points . . . 50

TABLE OF CONTENTS
(continued)

No. Page

2.6 Higher Education. 50

2.6.1 Campus-Oriented Programs. 54
2.6.2 External Degree Programs. 59
2.6.3 Universities Without Walls (UWW). 64
2.6.4 Summary of Channel and Delivery Point Requirements for the Higher Education Sector. 65

2.7 Adult Education 66

2.7.1 Delivery Systems. 67
2.7.2 Adult Basic and Compensatory Education. 68
2.7.3 Continuing Informal Education 71
2.7.4 Continuing Formal Education 71
2.7.5 Continuing Career and Professional Education 72
2.7.6 Continuing Professional Education 74
2.7.7 Satellite Channel Requirements. 76

2.8 Special Educational Markets 77

2.8.1 Migrants. 78
2.8.2 Correctional Institutions 82
2.8.3 Handicapped (Special Education) 88

2.9 Computer and Information Services 93

2.9.1 Interlibrary Cooperation and Distribution of Loan Materials 95
2.9.2 Information Networks. 98
2.9.3 Computer Services 100
2.9.4 Organizational Structure. 104
2.9.5 Total Channel and Ground Terminal Requirements. 107

2.10 Summary of Channel and Ground Terminal Requirements. 108

2.10.1 Public Broadcasting 108
2.10.2 Early Childhood Education 110
2.10.3 Elementary and Secondary Education. 111
2.10.4 Career and Vocational Technical Education . . . 112
2.10.5 Adult Education 112
2.10.6 Higher Education. 113
2.10.7 Special Educational Markets: Migrants, Handicapped, Correctional Institutions. 114

TABLE OF CONTENTS
(continued)

No. Page

2.10.8 Computer and Information Services 115

2.11 Summary of Possible Organizational Frameworks: The Educational Subsectors; Relation to Overall System. 116

3. Alternative Administrative Frameworks for Ownership and Operation of the Satellite Component. 123

3.1 Introduction. 123

3.2 Project Out-Reach 124

3.2.1 Control of the Satellite System 125
3.2.2 Channel and Ground Terminal Requirements. . . . 126
3.2.3 2nd Channel Public Broadcasting Service 128
3.2.4 Transition to A PBS-Owned Satellite System Serving Multiple Educational Sectors. 131

3.3 EDSAC 133

3.3.1 Funding for EDSAC 138
3.3.2 The Problem of Getting Started. 139
3.3.3 Standardization 140

3.4 SKYNET. 141

3.4.1 Ownership of Terminals. 145
3.4.2 Role of Government. 146

3.5 PILOT 146

3.5.1 Ground Terminals. 151
3.5.2 Financing 151

3.6 Conclusions 152

4. Concluding Remarks. 154

REFERENCES 157

LIST OF FIGURES

No. Page

1. Delivery Framework for Large Scale Telecommunications Services in Early Childhood Education 32
2. Organizational Framework for An Open Learning System at the Elementary/Secondary Level 42
3. Organizational Framework for Large-Scale Telecommunications Services in the Higher Education Sector. 53
4. Structure of External Degree Systems 61
5. Organizational Structure for Telecommunications Delivery of Adult Basic and Compensatory Education Services. 69
6. Structure of Telecommunications Program for Migrant Education. 80
7. Organizational Framework for Delivery of Educational Telecommunications Service to Correctional Institutions. . . . 87
8. Organizational Frameworks for Delivery of Educational Telecommunications Services to the Handicapped 92
9. Computer Applications in Education 103
10. Overall Organizational System Structure. 120
11. Possible Structural Arrangements for Various Educational Subsectors 121
12. Distribution of PBS 1st and 2nd Channel Services 130
13. Evolution of "Project Out-Reach" Satellite System from PBS to Non-PBS Control 132
14. Organization Structure of EDSAC. 134
15. Organization Structure of the Consortium of Education Sector SKYNET Users 144
16. Organization Framework for PILOT 149

LIST OF TABLES

No. Page

1. Estimated Short-Term and Long-Term Satellite Channel Requirements for Public Broadcasting. 26

2. Sources for School-Oriented Public Television Programming, 1971 37

3. Channel Requirements for Elementary and Secondary Education 46

4. Satellite Channel Requirement for Campus-Oriented Higher Education Services. 57

5. Summary of Transponder Requirements for a Hypothetical Large-Scale Educational Satellite System. 117

6. Summary - Ground Terminal Requirements for a Hypothetical Large-Scale Educational Satellite System. 118

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1. INTRODUCTION AND SUMMARY

In recent years, there has been growing interest in the possible use of large scale telecommunications systems to increase both the quality and efficiency of the educational delivery system in the United States. Developments in such communications technologies as satellites and cable have arrived at a time when there is considerable concern about the cost of education, quality of educational opportunity, and the need for a wider range of educational options for an increasingly diverse population of educational "consumers." Innovators in government, education and industry have speculated about the potential role of satellites in bringing about an educational telecommunications system of national scope. Educational telecommunications demonstrations utilizing the ATS-6 (Applications Technology Satellite) satellite are underway in the Rocky Mountain states, Appalachia, and Alaska. This memorandum is intended as a contribution toward building a framework for analysis of the costs and benefits of developing an operational educational satellite system in the U.S. We have attempted to shed light in two different areas.

In the first section, we have estimated the satellite channels and ground terminals that might be required to serve the educational sector. To arrive at these estimates, we have broken down the educational sector into several educational submarkets and prepared a scenario for each. Each scenario provides a rough indication of the satellite channels and ground terminals required to turn scenario into reality. Therefore, our satellite requirement estimates can only be as good as the scenarios themselves. However, it is hoped that other analysts will be able to use this as a starting point for developing revised estimates according to different judgments about what the future holds for education.

In the second section of this memorandum, we present four very different organizational alternatives for educational satellite system implementation and utilization.

1.1 MARKET SCENARIOS

We have projected a potential demand for as many as 25 full-time satellite channels.* The ground terminal requirements could run as high as 50-70 thousand units. Interestingly, so many of the services envisioned in our scenarios are of an interactive nature that all but a few terminals would need to be capable of both receiving and transmitting satellite signals, although only a few would have to be equipped with highly expensive return video transmission capability. These scenarios and estimates assume the use of high power satellites and low cost ground terminals similar to those being used in the ATS-6 demonstration.

1.1.1 Public Broadcasting

Only the public broadcasting submarket had previously defined its own satellite distribution requirements. Assuming total replacement by satellite of existing terrestial interconnection, the public broadcasting sector alone will require full-time access to 6-8 channels and part-time access to an additional 1-3 channels. As for ground terminals, public broadcasting will need at least 28 terminals capable of both sending and receiving television signals and an additional 99 terminals for receiving satellite transmissions at public broadcasting stations. These estimates are based on 1971-2 public broadcasting filings before the FCC. They also proceed on the basis that public broadcasting would be a user of satellite services, rather than an operator serving many other educational submarkets. Nevertheless, the potential importance of public broadcasting as a pioneer in the use of domestic satellite service for non-commercial and educational uses should not be underestimated.

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*One "channel" is equivalent in bandwidth to one television broadcast channel.

Extensive new planning activity is now going forward in public broadcasting to interconnect some 150 existing public broadcasting stations via satellite. Negotiations are underway with operators of low-power commercial domestic satellites on the basis of a requirement of four full-time transponders. This revised requirement has not been integrated into our report.

1.1.2 Early Childhood Education

Early childhood education, a sector consisting of children, parents, and teachers, is envisioned as a substantial user of satellite service, but primarily in the form of television programs distributed through the public broadcasting system. Therefore, this sector would no impose additional channel requirements. Some services such as computer-based services for early childhood education specialists are envisioned as being delivered outside the public broadcasting system, but the projected channel requirement would be small. The only ground terminal requirements would be for a transmit/receive unit located at a center housing early childhood educational materials.

1.1.3 Elementary and Secondary Education

The elementary and secondary education submarket seems to have potential for generating a substantial amount of educational telecommunications activity delivered outside of public broadcasting. Therefore, a substantial requirement of about 6 satellite channels and as many as 15-20 thousand limited transmit/receive terminals could develop. Satellite traffic envisioned includes instructional television for schools, a televised curriculum for delivery to students outside the conventional classroom setting, and a substantial amount of computer-based instruction and educational management services. As in the case with some of the other submarkets, significant accomodations within the state and local structure of elementary and secondary education in the U.S. are required before educational satellite services can ever be utilized.

1.1.4 Career and Vocational/Technical Education

In the career and vocational/technical education submarket, the prospects for satellite utilization seem greater in the career education area than in the vocational/technical area. The latter, which is concerned with teaching specific occupational skills, is seen as too fragmented a market to make satellite service practical. Career education, on the other hand, is concerned more with general career orientation and, therefore, lends itself to delivery by large scale telecommunications systems. FBS is seen as the primary delivery vehicle for career education. Other services using satellite channels would include a computerized job bank, computerized career guidance instruction, and some computer-based vocational/technical instruction. However, the total traffic load for this submarket is not large enough to require additional satellite channels. Delivery points would be common with those for other submarkets; so no additional ground terminals would be required.

1.1.5 Adult Education

Adult education, including adult basic and continuing informal and formal education will be users of services delivered via satellite channels allocated to public broadcasting and higher education. Satellite services delivered outside of these channels would be accommodated through occasional use of common carrier channels on private domestic satellite systems. As for ground terminals, there would be a need for 1 transmit/receive unit at an instructional resource center for continuing teacher education, and 2650 terminals with receive and non-video transmission capability to be located at private corporations and medical centers.

1.1.6 Higher Education

More than any other educational submarket, higher education appears to hold the opportunity for introducing the gamut of potential educational telecommunications services (including instructional television, teleconferences, computer-based instruction, remote batch processing, interactive computer applications in research and management, computer-based information storage and retrieval systems, and library networking). Satellite channels would be required for delivery to settings both on and off campus. Campus oriented services would require 4 full-time channels, while external degree programs would require 2 channels. An additional channel for education in the health sciences would bring the total channel requirement for higher education to 7, a substantial requirement. A total of 18 terminals with both receive and full video transmission capability would be required for external degree curriculum origination centers, health science education centers, and a higher education instructional television center. Less expensive, limited 2-way terminals would be required in 15-20 thousand locations. In its entirety, higher education is potentially a key user, because of the many opportunities for imaginative uses of telecommunications and because of the rather sizable satellite distribution requirements.

1.1.7 Special Educational Markets

Three special educational markets ("special," in the sense that they are isolated from conventional sources of educational services) have been singled out for analysis. They are migrants, inmates of correctional institutions, and handicapped persons. These potential markets are not meant to be inclusive. Other scenarios might be written for telecommunications channels to serve Blacks, and Spanish-heritage Americans.

Migrants

The population of migrant agricultural laborers and their families numbers about 1.4 million. Migrant children are deprived of preschool educational opportunities and suffer from lack of continuity in educational programs, caused by continuous moving from one occupational setting to another. Migrant adults are confronted with a shrinking demand for their services in the agricultural sector and with the concommitant need for educational "retreading" that will enable them to find other types of employment. Migrant families, as a whole, are seriously in need of family health education and language training.

Our scenario envisions development of a comprehensive migrant telecommunications program. The organizational framework for such a program would be a partnership of federal agencies, individual state education agencies, and multistate consortia, grouped in a pattern that conforms with the three major migrant "streams." Services envisioned include

K-12 instruction, specially adapted versions of early childhood programs offered by public broadcasting, career education for both children and adults, language training, a computer based school records transfer program, continuing education for teachers of migrants, and health education. One full-time satellite channel, four video transmit/receive terminals to be located at a national resource center and at three regional resource centers, and 30 mobile and 470 fixed location limited transmit/receive terminals would be required to implement these services.

Correctional Institutions

Attitudinal rehabilitation, vocational training and personal enrichment are three major educational needs of 420,000 Americans who are in jails and prisons. Of the needed educational services which lend themselves to delivery via satellite, most could be made available by importing services likely to develop in other submarkets for the "outside" population. Therefore, one additional full-time satellite channel would be sufficient. It would be used for such things as educational teleconferences among staff and inmates of different institutions and for televised instruction tailored for the prison population. 76 limited transmit/receive terminals would be required by federal and state institutions. Because the population of county and local jails tends to be highly transient, educational telecommunications may not make much of an impact at that level. In any case, terrestrial systems such as cable and ITFS could provide a conduit for relaying satellite signals from ground terminals to local institutions.

Handicapped

Several million school age Americans are afflicted with at least one form of mental or physical handicap. Of these, the mentally retarded, and individuals with impaired hearing or vision seem the most likely candidates for telecommunications based educational services. It has been thought that computer-based programmed instruction may be a useful educational tool for mentally retarded and emotionally disturbed children. Captioned television instruction for those with impaired hearing and electronically magnified display of educational materials for the visually handicapped are other services that appear to lend themselves to delivery via telecommunications systems. An already existing non-interconnected network of regional and state and local special educational materials centers could provide the basic framework for an educational telecommunications system for the handicapped.

In this scenario, it is contemplated that the telecommunications configuration in this submarket will consist of 22 video transmit/receive terminals located at regional media centers and 200 limited transmit/receive terminals at other centers. Delivery from these centers to end users in schools, hospitals and homes would be handled either by terminals in place for other submarkets or by terrestrial systems such as cable and ITFS. It is expected that access to one full-time satellite channel would be adequate.

1.1.8 Computer and Information Services

Many of the more exotic educational telecommunications services contemplated fall into the category of computer and information services. Networking of computer and information resources is a development from which all of the educational submarkets previously discussed stand to benefit. Computer and information networking can make these resources available to lightly populated areas and can have the effect of combining specialized resources scattered throughout the country into a nationwide pool of computer and information resources, accessible from anywhere in the U.S.

Three basic areas of development are envisioned: (1) inter-library networking for the purpose of sharing materials and administrative services, such as bibliographic and cataloging operations; (2) networking of specialized information banks; and (3) networking of computer systems to facilitate sharing of both hardware and software.

It is expected that development of computer and information networking will occur, at first, separately within various educational subsectors. Coalescing of the separate networks into a unified system will occur later. Hence, initial organizational efforts should be aimed at areas of cooperation which will facilitate the coalescing stage. These areas of cooperation include software standardization, coordination of channel usage, accessing protocol, development of mechanisms through which users can compensate suppliers, and organization for coordinating the distribution of development funds.

It is very difficult to estimate accurately the satellite channel requirements for computer and information networking. However, a requirement of 3-4 channels seems reasonable to us, based on the narrow bandwidth requirements for most of the types of services envisioned. Ground terminal requirements are fairly small, based on the assumption that most end user locations will belong to other educational submarkets already equipped with ground terminal facilities. An additional need for 3000 limited transmit/receive terminals at libraries and 400 similar terminals for end users at non-school locations is estimated.

1.1.9 Comment

Submarket by submarket analysis of the potential demand for satellite services leads to the conclusion that it is possible to at least make a plausible argument that the demand for satellite channels could be large enough to justify deployment of a rather large capacity satellite system for education.

1.2 ALTERNATIVE ADMINISTRATIVE FRAMEWORKS

Potential demand for satellite services is one matter. Having established that a potentially substantial demand or need may exist, it is necessary to confront the question of who will provide this service, and how the providing entity will be structured to develop and operate a satellite service in synchronization with the requirements of users.

To indicate the broad range of organizational options that are available for consideration, and to highlight some of the factors which may influence the choice of options, four very different hypothetical organizational arrangements for administering the satellite component of an educational telecommunications system are described here.

1.2.1 "Project Out-Reach"

"Project Out-Reach" is a satellite service organized to deliver programs of the Public Broadcasting Service to residents of the U.S. who reside outside the service areas of existing public television stations. These residents constitute about one-fourth of the population. If such a system comes into being, it would probably be more economical to use satellites in place of the existing terrestrial interconnection system than to maintain both satellite and terrestrial systems.

A second phase of development would be a second PBS network service, utilizing cable television systems as local outlets. Still a third phase of development would be a transition from a public broadcasting satellite system to a system serving other educational submarkets. Control of the satellite system would initially rest with a board of directors within the PBS structure but independent of PBS's non-satellite operations. The board membership would include representatives of rural areas not served by local public broadcasting stations. As demand for satellite service is generated in other educational submarkets, an advisory panel of non-PBS users would be added to the organizational structure. When non-PBS users account for 20% of total satellite usage, they would be represented on the board of directors in proportion to their usage until, at some point, non-PBS users would dominate the board, and public broadcasting would become just like any other user.

1.2.2 EDSAC (Educational Satellite Consortium)

EDSAC is a non-profit cooperative or consortium approach to educational satellite development. The EDSAC system would be owned and operated by a consortium of organizations representing major educational sectors in the telecommunications market. The approach is designed to maximize user participation in the design and development of an educational satellite system and to insulate the system from undue governmental influence. EDSAC would be governed by a board of directors elected by users. In addition to the satellite component, EDSAC would operate a network of regional resource centers and would employ a "Coordinator of User Services" to arrange for access to local non-satellite distribution channels, such as CATV, which are necessary for end-to-end delivery of educational telecommunications services. Although

EDSAC would own and operate regional resource centers (which would be points of entry to the satellite system), EDSAC would not be involved in production of software. Access to the centers would be on a "common carrier" basis. Government funding for EDSAC would be channeled indirectly through users, making the EDSAC system accountable to users rather than the government.

1.2.3 SKYNET

SKYNET would be a commercial satellite system serving a variety of users, in and out of education, whose networking requirements call for high power satellite/low cost ground terminal configurations. Educational users would be represented by a consortium, which would serve as liaison with the SKYNET corporation and would coordinate such terrestrial operations as a network of resource centers and coordinate other user support activities all the way down to the local level. The consortium would also maintain a "catalog" of software and services available to educational telecommunications users.

1.2.4 PILOT

PILOT would be a satellite system owned and operated by a government corporation and would provide bulk quantities of satellite channel time to private sector telecommunications organizations. PILOT would have a limited lifetime of 5-7 years and would be established for the purpose of encouraging the private sector to develop educational satellite services by demonstrating the demand for educational satellite service under market conditions. PILOT would be an attempt to overcome the "chicken and egg" problem in educational satellite development -- i.e., reluctance of the private sector to assume the investment risk of developing a system until demand has been demonstrated, and inability of education to demonstrate demand until a satellite is available. Although the satellite system would be owned by the government corporation, private entities would be responsible for marketing the system.

1.3 OVERVIEW

In the pages which follow, supporting material for the information summarized previously is presented. The report is divided into two main sections. The first section develops market scenarios, and channel and ground terminal requirements for a large-scale educational telecommunications system. The second section lays out some alternative organizational frameworks for such a system.

This report represents one of a series of studies undertaken by the Center for Development Technology, primarily under NASA sponsorship, to explore possible uses of communications satellites in U.S. education. Two documents which are companion works to this report are a study of "Educational Needs and Technological Opportunities for Large-Scale Educational Telecommunications Systems," and a "Preliminary Assessment of Potential Impacts of Educational Telecommunication Systems."

In many ways, the work presented herein is highly speculative in nature. Other market scenarios can be written and other alternative administrative structures defined. Hopefully, our work will serve as a basis for further investigation and discussion.

Much of this study was completed by May of 1974. Since then, a number of important developments have occured which we have at least tried to refer to in the report. They include the creation of a Public Service Satellite Consortium, involvement of the Public Broadcasting Service in plans for satellite interconnection of 150 public broadcasting stations, a study of possible new educational initiatives by the Advisory Council of National Organizations (ACNO) to the Corporation for Public Broadcasting (CPB), satellite cost-effectiveness and market studies carried out by the Office of Telecommunications Policy of the Department of Health, Education and Welfare, and the launching of NASA's ATS-6 satellite for the Health-Education Telecommunications experiment. Much of our work, however, does not reflect this recent flurry of activity. In addition work nearing completion by Morley and Eastwood of our research group indicates that we may have underestimated the channel requirements for computer-assisted instruction. The need for continuing study and refinement in the educational satellite area is clearly evident.

2. MARKET SCENARIOS

2.1 INTRODUCTION

The following section is a collection of scenarios, briefly depicting potential educational markets for communications satellite services. Ongoing needs analysis studies at the Center for Development Technology [1,2,3,4,50] have explored needs and trends in specific sub-sectors of eduction which appear to provide opportunities for using large scale telecommunications networks.

This memorandum goes a step further by attempting to speculate about future educational networking in terms which are specific enough to facilitate estimates of system capacity requirements and configuration and therefore, at a future date, systems costs. The words "attempting to speculate" cannot be accented too much. In estimating such things as channel requirements, which depend on the demand for services, we venture into an area where more is unknown than known. Since the overwhelming majority of potential users of satellite-delivered educational services are currently unfamiliar with satellite technology and its possible applications, and since with the exception of the ATS-6 satellite experiments there is essentially no current use of satellites in education as well as relatively low utilization of all forms of technology in education [51], there is no reliable way of measuring future acceptance or lack of acceptance. Using the "Delphi" technique, Robinson [5] has developed a forecast of utilization levels for television, computers and information services in various educational sectors in the 1980-1990 time frame. However, even if this forecast proved accurate, Robinson's utilization levels cannot be translated directly into the specific terms approached in the following analysis.

One reason it is so difficult to estimate demand is that it is necessary to think beyond the current services and organization of American education. Many non-traditional educational services are in relatively early stages of development. Among these are early childhood education, career education, education for the handicapped, education for culturally diverse groups and geographically isolated regions, electronic library and information services, and home-oriented services. Because of built-in resistances to innovation in agencies of traditional education, there is reason to believe that telecommunications networking may make its greatest initial impact in the non-traditional areas. Until we know the extent to which the nation commits itself to developing these new services, it is nearly impossible to project the penetration of technology.

Given the uncertainty of future educational networking, what is the point of even trying to develop estimates of channel capacity requirements and costs? One major hope is that such estimates, tied to descriptions of hypothetical future applications of telecommunications networking in specific sectors of education, will help interested parties to better visualize concepts which, to this point, have been discussed either in general terms or in terms which relate only to existing institutions, such as public broadcasting.

In this study, eight major markets for satellite services are explored: (1) public broadcasting; (2) early childhood education; (3) elementary and secondary education; (4) career and vocational/technical education; (5) higher education; (6) adult and continuing education; (7) education for groups with distinct needs, including migrants, prisons and the handicapped; (8) computer/information networks.*

A brief scenario is spelled out for each sector, and, following that, all sectors are aggregated into a single picture in a market summary. No attempt is made to describe all the possible scenarios for each sector. Instead, one scenario, hopefully plausible, is emphasized for each sector. It is hoped that this approach at least provides a starting point for discussion, modification and planning by decision-makers as well as the general public.

To facilitate comparison among various educational sectors and aggregation at the end, a common format is followed in describing each sector. One imaginative means of building scenarios is the style employed by Parker [6] and Robinson [5], describing the future in the present tense and the present in the past tense. This analysis will, instead, keep the reader in the present and outline the future from the vantage point of today.

Financial and technical requirements of an educational telecommunications system using satellites will be largely determined by four major variables which are considered here for each sector, as appropriate:

1. Services -- the respective roles of television, instructional and non-instructional computer applications, information networking.
2. Organizational structures -- sponsoring agencies for cooperative production, storage, distribution and utilization of satellite-delivered services.
3. Delivery points -- numbers and locations of various types of satellite ground terminals.

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*This breakdown does not correspond exactly to a previous "Needs Analysis" report [50], although that report has been used to an appreciable extent as a basis for this study.

4. Channel requirements -- satellite channel capacity required during various time periods.

After each educational sector is considered separately, estimates of delivery point and satellite channel capacity requirements will be summed up to establish a basis for estimating the requirements and costs of a high-power educational satellite system. The setting for some of the following descriptions may be in the 1990 and after period, when development of educational telecommunications systems and demand for satellite-based services may have reached a fairly mature stage, following a series of pilot projects and demonstrations using NASA's ATS-6 and CTS spacecrafts and following deployment of second-generation domestic satellites.

2.2 PUBLIC BROADCASTING

Public broadcasting, consisting of the Corporation for Public Broadcasting, (CPB) Public Broadcasting Service (PBS), and National Public Radio (NPR), with their affiliated non-commercial broadcasting stations, constitute the only portion of the vast educational market for which satellite distribution requirements have previously been analyzed and defined by the user group itself. [7,8] If an educational satellite system were deployed today, public broadcasting could immediately be a significant user, provided the price was right. However, the stated requirements of public broadcasting may not of themselves be sufficient to generate public enthusiasm for a dedicated satellite system supported with public funds.

It should be noted that the requirements which have been stated are concerned basically with what is needed to transfer current and anticipated near-term public broadcasting services from terrestrial to satellite distribution. They do not take into account some potential long-range developments in public broadcasting, including expansion of regional and state networking and a second schedule of national programming services. Described here are the satellite channel requirements for delivery of current services, and for longer-range services.

In late 1974 and early 1975, the Public Broadcasting Service has been exploring the possibility of interconnecting 150 public television stations via satellite, with financial assistance from the Corporation for Public Broadcasting and Ford Foundation. Such interconnections would be accomplished via fairly expensive ground terminals and relatively low power satellites. Negotiations are underway with commercial domestic satellite operators for 4 full-time transponders to serve the 150 stations.* This development has not been integrated into the forthcoming scenario, which is based upon previous PBS requirements as stated before the FCC in 1971.

2.2.1 Near-Term Requirements

The Corporation for Public Broadcasting (CPB) and PBS have spelled out the channel requirements for public broadcasting in response to the commercial domestic satellite proposals which were filed in 1971 with the Federal Communications Commission. [7,8] Public Broadcasting and most other potential educational users of satellite distribution require three basic types of access to satellite channels:

Full-time channels -- dedicated

Scheduled access -- regular or predictable usage part-time; channel shared with other users.

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*Personal communication from Daniel Wells to Robert Morgan, 3/17/75.

Unpredictable -- access to channels on an irregular occasional basis to meet unexpected requirements, such as news event coverage. Channel availability needed on 3 hour advance notice.

In their May 12, 1971 filing with the F.C.C., [7] CPB and PBS stated their channel requirements, which are summarized below:

1. Two full-time non-preemptible channels with back-up capability are needed for delivery of the basic national programming service with a three hour time delay for the West Coast.

   A more recent statement of channel requirements [8] (1972) expressed a need for three, rather than two, full-time channels, with a possible need for a fourth channel.

2. One additional channel on a scheduled access basis for 31 hours per week for regional programming within the six regional public broadcasting networks*, for special time delays and for assembly of program segments from member stations by a central program assembly point.

   The December 1972 statement of requirements [8] sets the scheduled access need at 42 channel hours per week (3 channels, 2 hours/day, 7 days per week) for regional programming and 16 additional channel hours per week (1 channel, two hours/day, 6 days per week and four hours on Friday) for program assembly.**

3. One channel on an unpredictable need basis for about seven hours per week.

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*Eastern Educational TV Network (EEN), Central Educational Network (CEN), Southern Educational Communications Association (SECA), Western Educational Network (WEN), Rocky Mountain Public Broadcasting Network (RMPBN), Midwest Educational Television (MET).

**"Program assembly," in this context, means construction of television programs using TV program materials transmitted via satellite from PBS affiliates to a central point, where the contributions from affiliates would be edited into a finished product.

National Public Radio also desires access to satellite channels for distribution of stereophonic programs, which terrestrial circuits transmit poorly due to their insufficient bandwidth. [7] Distribution of stereo programs has been accomplished by mailing tapes to member stations. The bandwidth requirements even for stereophonic audio (pairs of 15 KHz circuits) is so minimal as to have an inconsequential effect on satellite requirements.

In sum, near-term satellite requirements are 2-4 dedicated channels, 1-3 channels on a shared, scheduled access basis for 31-42 channel hours weekly (mostly daytime, for instructional programming); 1 channel on a shared basis for 16 channel hours weekly of program assembly, and 1 channel on an unpredictable basis for about 7 hours per week.

2.2.2 Long-Term Requirements

The near-term satellite channel requirements of public broadcasting are the only requirements which have been clearly stated by any sector of the educational community. The long-term requirements are uncertain and depend on many factors, including the extent to which the balance between regional and national distribution shifts and the future role of public broadcasting in a fully developed educational telecommunications system.

Regarding the balance between regional and national programming, a 1972 study indicated that about one-fourth of public broadcast time is local programming, and almost one-half of PTV programming originates from national sources. [9] Results of Robinson's "Delphi" study [5] indicate that national organizations will provide a greater portion of educational software in general than will any other level. In public television there appears to be some tendency at present to favor decentralization of programming. If the regional networks increase their role in PTV, requirements for access to satellite channels would increase over that required for national distribution alone. The extent to which current and projected satellite technology can accommodate regional "splits" requires further study.

Assuming a shift in favor of regional networking, it seems reasonable to double the requirements stated for the near-term. This would mean an increase from 42 to 84 channel hours per week for regional programming. This would still involve shared channels utilized on a scheduled access basis. The number of scheduled channel hours for program assembly could also increase from 16 to 26. (1 channel, 4 hours per day, 6 days per week and two hours on Sunday). This would permit greater local participation in national program development.

As for the future role of public broadcasting in a fully developed educational telecommunications system, this scenario makes a choice between two very distinct possibilities. On the one hand, it is possible to envision PBS or CPB as an umbrella organization for all educational services delivered via broadcast television. A PBS owned and operated satellite system (see section3.2 on alternative administrative frameworks) could not only provide the channels for distribution of educational services, but could also play a key role in promoting, financing and coordinating nationally distributed educational telecommunications activity.

This scenario sees a very different role for public television. Here it is useful to note that "public television" (PTV) and "instructional television" (ITV) are usually encompassed by the term "educational television" (ETV). PTV usually connotes the cultural entertainment and public affairs variety of programming telecast by PBS during prime-time, whereas ITV connotes more formal, structured educational programming with specific learning objectives in mind.

It has often been suggested that CPB and PBS play a greater role in development of instructional programming. [10] To some extent, public television has already expanded its activity in instructional television with the development of such programs as Sesame Street and Electric Company, which although not primarily designed for use in schools, have resulted in substantial in-school use. CPB currently is supporting an extensive study of future involvement in education-related activity by its principal advisory body, ACNO. A scenario depicting a greatly enhanced, central CPB-PBS in educational telecommunications is clearly within the realm of real possibility.

However, we have envisaged a pattern of long-run development in this scenario which involves public broadcasting as one of several major educational telecommunications system users rather than as either an organizational or distributional focal point. From an acceptability standpoint, one big factor working against an organization such as PBS functioning as a central control point or focus is that public broadcasting is funded and, to a large extent, coordinated by a national quasi-governmental agency, CPB. Therefore, there might be overtones of a national government educational superagency. Furthermore, PBS, as primarily a broadcasting rather than an educational organization, is not currently structured to coordinate educational activities. Adjustments in the organizational structure of PBS that would be needed in order for it to function as the focal point of a large-scale educational telecommunications system are discussed in 3.2.

The future role of public broadcasting, according to this scenario, then, is to continue as a conduit for enrichment-type educational programming and some instructional programming, especially in the early childhood, adult basic education, career education and "external degree" areas (discussed in following scenarios). Except for the case of "Project Out-Reach" discussed in Section 3.2 the educational sectors identified in this collection of scenarios follow a course of primarily separate development, with access to satellite channels independent of public broadcasting. However, the importance of public broadcasting in the over-all non-commercial telecommunications picture and its current interest in education should not be overlooked.

If separate development is the prevailing pattern, then the long-term requirements for channels allocated to public broadcasting are less than they would be if, for example, such innovations as the Open University concept were to be implemented through the use of channels controlled by public broadcasting. In a sense, this is merely a juggling of the books, since the total channel requirement for education is not affected, only the requirement for channels allocated to public broadcasting.

Expansion of public television service in the long-run could be expected to take the form of expansion of both national and regional service. Major areas of expansion could include:

1. Development of a second service utilizing cable headends. The second national service would, in addition to offering repetitions of programs on the first service, offer more children's programming, informal adult education, public events coverage, consumer education, etc. A second service would require addition of two channels, the extra channel for time zone delay purposes.
2. Limited formal instructional programming for adult basic education, similar to the Adult Learning Program Service (ALPS)

which was proposed but never implemented by CPB. [2]

3. Increased regional programming. Some of the additional programming would be regional delayed playbacks of nationally distributed ALPS-type programming. Regional distribution of Public Television Library (PTL) materials would be another service. The combined channel requirements for instructional and increased regional programming could be met by 2 additional full-time channels.
4. Extention of national program services to 24 hours. Most of the extra hours would be utilized for program repetitions, so that people can enjoy the benefits of public television, no matter what their work schedule. The late hours could also be used to distribute programs to stations for later playback to audiences. This extended service could be accommodated by the full-time channels already allocated to public broadcasting for short-term requirements.

As shown in Table 1, the anticipated long term satellite channel requirements envisaged for a public broadcasting system not committed to being the telecommunications agency for numerous other sectors of education are substantial. Six to 8 full-time channels, 1-3 part-time channels available on a scheduled access basis, and 1 channel for unexpected short-notice needs would be required.

To this point, long-term satellite channel requirements for public broadcasting have been considered. It is assumed that the basic organizational structure of public broadcasting will remain, with local member stations having a strong voice in making national programming decisions. Categories of services and probable areas of expansion have also been outlined.

TABLE 1

ESTIMATED SHORT-TERM AND LONG-TERM SATELLITE CHANNEL REQUIREMENTS FOR PUBLIC BROADCASTING

	Full-Time	Part-Time Scheduled Access*	Unpredictable, Short Notice
Short-term:	2-4 channels	1-3 channels, 31-58 channel hours. for: Regional Programs Time Delays Program Assembly	1 channel 7 hours/week
Long-term Additions: (1980-90)	4 channels	10 channel hours for Program Assembly.	7 hrs/wk
Total Requirements, Long-term:	6-8 channels	1-3 channels, 41-68 channel hours.	1 channel 14 hrs/wk

*Most requirements expected to be during daytime, evenly spread throughout the week.

One area which reamins to be commented upon is the matter of delivery points. It is difficult to assess the need for satellite ground terminals separately for each educational sector, since, for many cases, there will be sharing of facilities. With respect to public broadcasting, however, it seems reasonable to assume a need for dedicated ground terminals, i.e., terminals colocated with, and used solely by, public broadcasting stations. These terminals would be utilized on a full-time basis, so sharing with other users would not be possible. The number of terminals required would be the same for both short- and long-term requirements, but utilization would be intensified. If a second service utilizing cable headends develops, a large number of ground terminals would be added; but this requirement falls into the category of terminals used by several educational sectors. Here, only the requirements for those terminals to be used solely by public broadcasting are noted. To extend PBS coverage to rural areas, as discussed in section 3.2 would require additional terminals. However, these terminals would be shared by several educational sectors, unless the satellite system were deployed solely for extension of PBS coverage, as discussed in connection with "Project Out-Reach" in section 3.2.

In 1972, PBS defined its ground terminal requirements as follows:

Receive - only terminals:	98 one-channel receivers
	1 four-channel receiver
	99
Receive/Transmit terminals: (capable of both receiving and transmitting video)	28*

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*From reference [8]

It should be noted that an advanced satellite system is likely to cover the United States with switchable beams; i.e., multiple beams which cover different areas of the continent, using the same channel. The optimal beam configuration depends on the other sectors as well as public broadcasting. But it is worth at least mentioning that dividing coverage of the U.S. among several beams will increase the number of different regional programs which can be distributed simultaneously via a single channel.

2.3 EARLY CHILDHOOD EDUCATION (ECE)

Early childhood education can be subdivided into three submarkets: education for preschool children; education for early childhood teachers and paraprofessionals; and education for parents of preschoolers [providing parents with guidance on how to nourish their children's desire and ability to learn.] [3] There are several reasons public broadcasting will likely play an important role.

First, in the form of "Sesame Street" and other child-oriented educational programs, television has proven itself to be an effective tool. As Rothenberg [3] has pointed out, the prospects for using one-way broadcast television appear to be better than the prospects for interactive video and computer services in early childhood education. Robinson's study [5] also indicates televised instruction will be far and away the dominant telecommunications service in early childhood education. His report also indicates that computer instruction and information services will have achieved only a developmental status by 1990. Since television is currently the business of CPB and PBS, participation by these organizations in the delivery of early childhood education services seems appropriate.

A second factor is that public broadcasting has led the way in the use of large scale telecommunications in early childhood education. In fact, the success of "Sesame Street" helped create a favorable climate for development of early childhood education in general by demonstrating that 3-5 year olds are willing and able learners. Together with Children's Television Workshop, CPB and PBS have established themselves in the early childhood development field.

Third, early childhood education lends itself to a mass media approach. The audience for early childhood education programs is to be found in a variety of settings, including homes, nursery schools, and day care centers. The child and parental audiences number in the millions, thereby justifying and even requiring, the use of a mass medium for distribution. This is probably not the case for the third part of the market; teachers and paraprofessionals.

Fourth, the nature of early childhood instruction is informal and participation is voluntary. Although parents and educators as well as government officials have become increasingly aware of the potential for pre-school learning, this scenario does not anticipate mandatory pre-school enrollment, which would be accompanied by a need for some kind of accreditation/certification mechanism. It is conceivable that a broadcasting organization such as PBS could "hire out" as delivery agents but not coordinators to educational organizations. In fact, local public stations do this frequently for local schools. However, if the educational service offered is not subject to accrediting requirements and if those who partake of the service don't do so "for credit," PBS can begin to serve them without waiting for educational organizations to "get together" on a mechanism for sponsorship and accreditation of such efforts. Hence the prospects for PBS involvement are good in the early childhood sector.

Given that television is to be the primary large scale telecommunications service in early childhood education, and that the agencies of public broadcasting are to be the key players in both organization and distribution, the satellite channel capacity required for the early childhood sector, above that required for public broadcasting is limited. The largest share of the demand for access to satellite channels will be accommodated by the capacity already allocated in the scenario for public broadcasting, including channels for regional activities. It is anticipated that a good portion of national and regional public broadcast programming in daytime hours will be devoted to an expanded schedule of early childhood education programs.

This scenario envisions a three-hour block during weekdays devoted to national early childhood education programming. Distributed by PBS, the program block will interface with such regional organizations as the Federation of Rocky Mountain States and the Appalachian Pre-School Education Program, [3] which will implement field support services, including program promotion, home visitations, classroom-oriented supplementary activities, evaluation and feedback.

In addition to the three-hour block which is oriented toward the children themselves, it is expected that PBS will provide a schedule of programs oriented toward the children's parents. Although this will amount to only an hour of new programming per week, the program will be repeated a number of times during the week on either the main PBS channel or on the second PBS service distributed to cable headends.

The probability of using public broadcasting to serve the third part of the early childhood education market, early childhood education teachers and specialists, seems less certain, for two reasons. First, the audience may not be large enough to justify using a mass medium.

U.S. Department of Labor projections indicate a need for 23,000 newly trained child care workers who, in turn, will be in need or regular continuing education to keep up with the state of the art. [3] However, the market is still small for a medium accustomed to serving millions in a single hour of programming.

A second reason for downplaying the role of public broadcasting in serving early childhood education specialists is that education for this market is increasingly likely to fall into the category of formal instruction. While the growing number of 3-5 year olds participating in learning activities may continue to grow on a voluntary basis, there is a good possibility that states will begin to require that early childhood specialists have formal educational credentials. Thus, states will be more inclined to coordinate programming themselves and to require access to their own channels, over which they can maintain greater control of scheduling, than they could over a broadcasting organization's schedule.

Thus, instructional services for early childhood educators would join a number of other services for this sector which would generate a demand for satellite capacity over and above that already absorbed by public broadcasting. As shown in Figure 1, early childhood specialist training, field support activities, special regional programming, such as bilingual materials, and special computerized information systems for educational management operations would be coordinated through regional organizations. To procure satellite channels, regional organizations might either go through a national early childhood education consortium or to a national educational telecommunications coordinator. This coordinator might be either a commercial satellite entity, a user-controlled consortium, or any other entity able to provide satellite circuits. Also

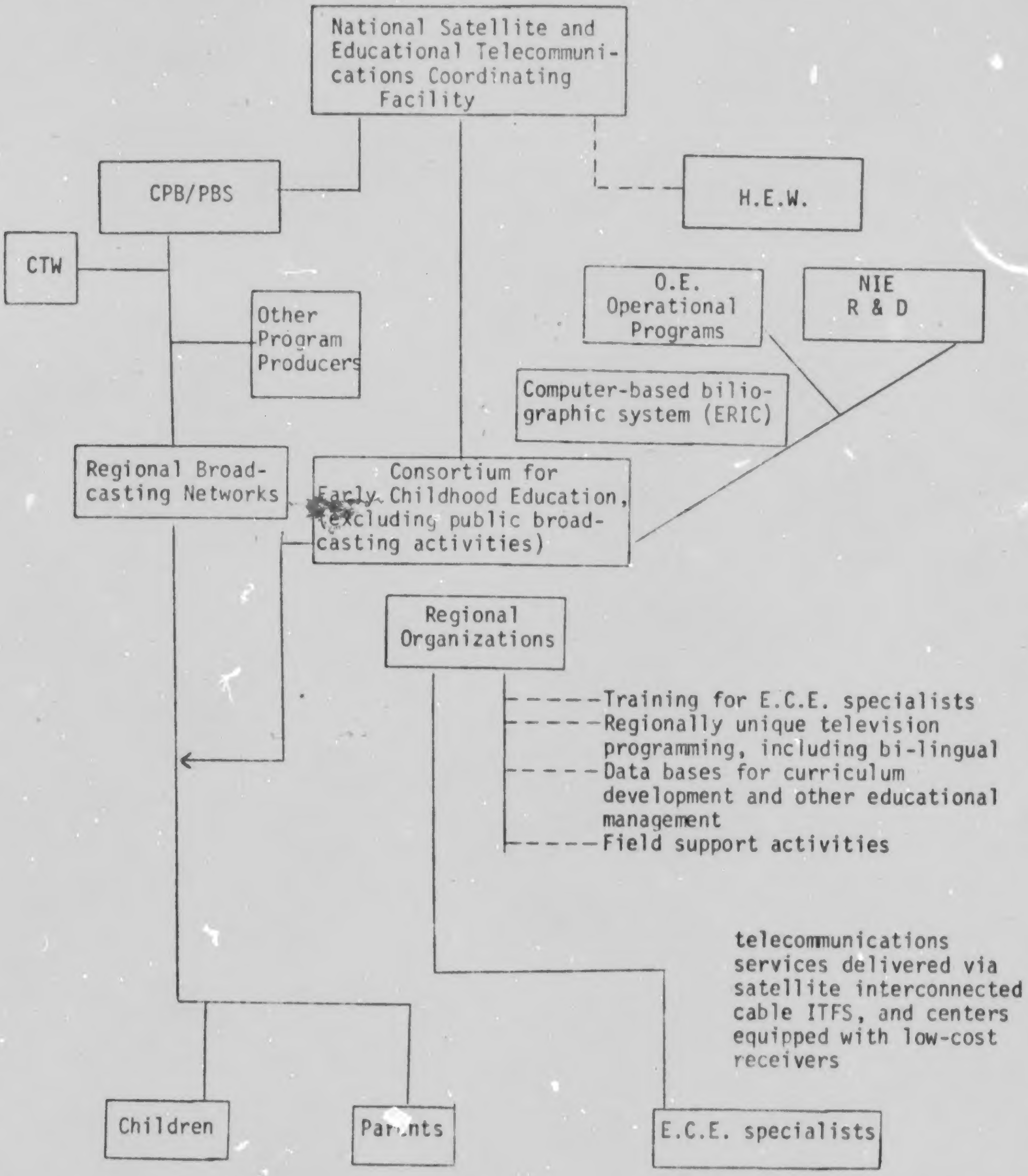
National Satellite and Educational Telecommunications Coordinating Facility
CPB/PBS
H.E.W.
CTW
Other Program Producers
O.E. Operational Programs
NIE R & D
Computer-based biliographic system (ERIC)
Regional Broadcasting Networks
Consortium for Early Childhood Education, (excluding public broadcasting activities)
Regional Organizations
Training for E.C.E. specialists
Regionally unique television programming, including bi-lingual
Data bases for curriculum development and other educational management
Field support activities
telecommunications services delivered via satellite interconnected cable ITFS, and centers equipped with low-cost receivers
Children
Parents
E.C.E. specialists

Figure 1

Delivery Framework for Large Scale Telecommunications Services in Early Childhood Education depicted in Figure 1 is the concept of PBS operating without direct linkage to the consortium for development of early childhood education. When needed, there is a link between PBS and regional organizations to facilitate field support activities. Many of the programs which would require channel space in addition to that allocated to public broadcasting would be developed by the early childhood education consortium, with financial and advisory assistance from the Office of Education.

The "National Satellite and Educational Telecommunications Coordinating Entity" at the top of Figure 1 represents a variety of possible types of organizations. It could range anywhere from a commercial common carrier satellite firm to a satellite system controlled by a consortium of users to a dedicated satellite system, owned and operated by the educational sector in question; in this instance, a consortium for early childhood education. The figure is intended to illustrate lines of communication, not lines of authority. Therefore, the figure should not be construed to mean that a new superagency in authority over CPB or H.E.W. would be established.

Some of the "extra" services envisioned are computer-based, including educational information/management services, a computer-based equivalent of ERIC* and a limited amount of CAI.** Although important services, they are not large in terms of channel space utilized. Other extra services offered on a regional basis involve greater bandwidth consumption. These include special regional television programming for all three sub-markets in the early childhood sector and various forms of teleconferencing for training and continuing education of early childhood specialists.

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*Educational Research Information Center -- ERIC is a nationwide network of libraries which collect and circulate educational research materials.

**Computer-assisted instruction.

It is expected that utilization of these services would be primarily during weekday, daytime hours (8 a.m. to 5 p.m.). In a satellite system using a switched beam configuration, so that a single transponder can be used simultaneously for more than one regional program, one transponder available during the time required would probably be sufficient to meet the requirements of the non-public broadcasting portion of the early childhood education sector.

2.3.1 Delivery Points

As in other sectors, many of the delivery points required to serve early childhood education in an educational telecommunications system would be terminals shared with other educational sectors. This is especially so in early childhood education because of the heavy reliance on public broadcasting for distribution. (The configuration of shared delivery points will be discussed after the separate sectors have been considered. Until then, only those delivery points which are to be used exclusively by the sector in question will be discussed.) In the case of public broadcasting, a whole network of dedicated terminals was required. In the case of early childhood education, no requirement for dedicated facilities is expected, except for an origination (uplink) point for a center controlled by the Consortium for Early Childhood Education. The center would house the computer-based bibliographic service and would distribute video programming not channeled through the public broadcasting system. The possibility of direct-to-daycare center or direct-to-home delivery in rural areas has not been incorporated into this scenario because of the belief that the rural audiences will more likely share community satellite receivers, gaining access either through cable redistribution or community learning centers colocated with the satellite receiver.

The center would distribute some programming to regional centers (shared by early childhood education with other sectors) for redistribution and, in some cases, distribute materials in real time to a national network of users.

In summary, requirements for early childhood education are as follows:

Satellite Channel Requirements

1 Channel on scheduled access basis between 8 a.m. - 5 p.m., Mon. - Fri. (45 hours)

Dedicated Terminal Requirements

1 Receive/transmit terminal

0 Receive only terminals

0 Receive/narrowband return terminals

2.4 ELEMENTARY AND SECONDARY EDUCATION

Unlike early childhood education, the elementary and secondary education sector seems likely to develop a significant amount of activity apart from public broadcasting. The politics and organization of public education and private elementary and secondary education militate against a domineering role for public broadcasting. Education is a very local, decentralized activity in this country. This fact places very real constraints on the interaction between public broadcasting and this sector. Also, enrollment in elementary and secondary education to a certain level (it varies by state) is mandatory; curricula must be accredited by states [12], and teachers must be certified.

This does not mean there will be no role for public broadcasting in a large scale telecommunications system serving elementary and secondary education. On the contrary, in 1971, 35.4% of total hours broadcast by public television stations was programming for schools. Of this programming, only 35.9% was produced locally. Although only 10.1% was delivered by national or regional interconnection, it is significant that NET*, NIT,** GPNITL,*** non-local PTV stations, and commercial syndicates such as McGraw-Hill, accounted for 27.8% of programming for schools. [9] Table 2 shows sources for public television programming.

School-oriented programming helps public television stations fill their daytime schedules, and production contracts from local school systems provide a source of revenue. Nevertheless, as of 1967, it was estimated that only 3 to 5% of classroom time in schools was devoted to instructional television. [13] If it is assumed that there will be an eventual expansion of ITV to 20% of classroom hours, it might be expected that non-local public broadcasting would be the delivery vehicle for about 5-10% of all classroom hours. The other 10-15% would be delivered by local public broadcasting, ITFS, cable, and state and regional networks of schools interconnected by satellite circuits. If the typical week continues to consist of 30 classroom hours, it can be seen that 6 hours would be accounted for by instructional television. Perhaps 1/2 of those hours would be imported by satellite interconnection other than public broadcasting.

In a switched-beam configuration, perhaps two full-time transponders would be sufficient to meet the demands for television distribution. During day-time hours, these transponders would be used mostly for real

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*National Educational Television

**National Instructional Television Center

***Great Plains National Instructional Television Library

SOURCES FOR SCHOOL-ORIENTED PUBLIC TELEVISION PROGRAMMING, 1971*

Program Source	Percentage of Hours from Each Source
Produced locally	35.9%
Delivered by national interconnection	6.9%
Delivered by regional interconnection	3.2%
Delivered by other interconnection	5.5%
Film and tape distributed from:	
National Educational Television	1.8%
Regional Networks	6.5%
ETS/Program Service	1.1%
National Instructional Television	10.6%
Great Plains National Instructional Television Library	9.0%
Other PTV Stations	5.6%
Commercial Syndicates	0.8%
All other Sources	13.1%
TOTAL	100%

TABLE 2

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*From Reference [9].

time networking. In the evening and on weekends, these channels could be utilized for distribution of programming to regional and local tape delay centers and for teleconferencing and other continuing education for teachers activity.

DuMolin and Morgan [14] have described an instructional satellite system in which programs would be distributed to schools on a demand access basis. However, due to the relatively high cost of a single hour of satellite time over all the continental United States, the economic feasibility of such a demand access system is open to serious doubt. But if schools can cross their highly decentralized boundaries to engage in cooperative scheduling of particular programs, the economic viability of a semi-demand access system would be improved.

This is an area where cooperative program development and non-public broadcasting distribution channels come into play. A consortium of users, including state education agencies which must accredit programs, is already beginning to take shape in the form of the Agency for Instructional Television (AIT). If schools desiring specific instructional television programs or series join together to finance and develop programming, then it is only a step further for AIT to lease its own satellite channels and to be the agent for cooperative scheduling of program distribution. Since the agency would be largely financed and governed by users, its success might be far easier to achieve than would success for a distribution system organized under the auspices of a broadcasting agency like PBS. As previously mentioned, these channels could also be utilized for networking schools for teacher training activities.

In addition to instructional television services, the potential for such computer-based services as CAI, educational management and information services, including bibliographic search and a computerized "reference shelf" for students and teachers also exists.

Although Robinson's "Delphi" study [5] indicates television will be the medium achieving the highest level of utilization* in elementary and secondary education by the year 1990, the study also indicates a moderate level of utilization for computer instruction and information services in schools and institutions.

Major computer-based services which would stand a good chance of being utilized by elementary and secondary education and delivered by satellite in a mature educational telecommunications system include:

...regional CAI networks modeled after the PLATO-IV system.

...regional and state time-sharing networks for administrative/instructional applications.

...an on-line ERIC system**

...computer-based reference services shared with users outside of elementary and secondary education. These might include the New York Times data bank, state and regional reference services controlled by library and government agencies, and specialized data banks.

Since these services do not consume as much bandwidth as television does, and since some will be services not dedicated to elementary and secondary education, it would seem reasonable to estimate that an additional one or two full-time transponders capable of handling the equivalent of one video channel each would be sufficient. However, this estimate is nothing more than a guess, in part because of the difficulty

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*"Level of Utilization," as used in the context of Robinson's study, indicates the proportion of places making some use of a service. It does not indicate the intensity of usage - i.e., the proportion of the instructional hours using the service.

**Educational Research Information Clearinghouse of estimating utilization.* These services are different than ITV in that they would likely be almost as heavily utilized at night as during the day. CAI lends itself to independent, after school use, and reference services would have many "homework" applications.

2.4.1 Open Education

The earlier discussion of instructional television and, to an extent, the discussion of computer-based services were pretty much oriented to the traditional, classroom style of education. This scenario also foresees a need for and establishment of an "open learning" system, especially for the advanced elementary and secondary levels. Such a system would be designed to serve the needs of three categories of users:

1. Those who simply don't find lock-step, classroom-centered education to be a satisfying or compatible learning style, including exceptionally fast or slow learners.
2. Those who belong to families which are highly mobile, (such as migrant farm laborers, children of military personnel, and children of people whose corporate employers require frequent transfers), who thereby miss continuity in instruction from semester to semester.
3. Those who are confined to homes or hospitals and who are, therefore, unable to participate in classroom activity.

This scenario envisions a nationally coordinated Open Elementary and Secondary School Curriculum designed to serve learners who are old enough to benefit from a form of education that is necessarily less closely supervised than classroom-centered education. In this group, we have included learners of the 4th-12th grade level category.

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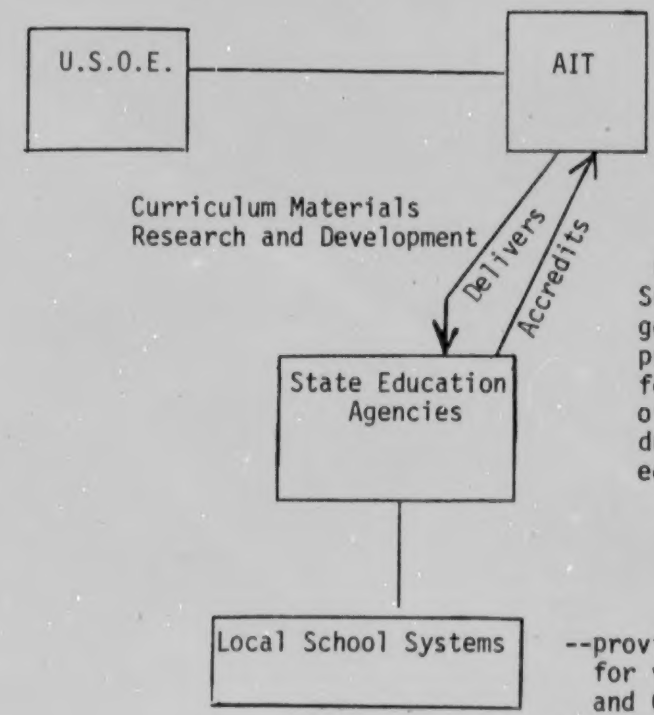
*Morley and Eastwood are studying communication requirements for nationwide dissemination of PLATO-IV type CAI. Preliminary results indicate that CAI channel requirements may be sizeable. Therefore, CAI channel requirements have been underestimated in this memo and need reexamination.

The organization of such a service must mix as well as possible with the existing elementary and secondary school system. With this in mind, the system designer might conclude that the Open School Curriculum should have a high degree of grass roots participation and that coordination of curriculum development and distribution at the national level be handled jointly by the Office of Education and the developing Agency for Instructional Television. Not only would grass roots participation be implemented by state education agency participation in governance of AIT, but local school systems would be engaged to provide field support services. Among the services provided would be use of school space as viewing centers for mobile students, tutoring, access to CAI terminals, administration of testing and evaluation certified by the Educational Testing Service (ETS). Accreditation of the service would be coordinated between ETS and the recognized regional accrediting associations. Certification of students could be awarded either in the name of ETS or jointly by ETS and state education agencies.

However, as a practical matter, the currently entrenched organization of K - 12 education in the United States may require that complete responsibility for testing, evaluation and certification of students be left at the state education agency level. Recognition of this and other political realities could well be the key factor in acceptance or non-acceptance of new telecommunications technology in public education. Figure 2 illustrates this concept.

The channel capacity required to deliver the Open Curriculum would be handled by three channels available between 8 a.m. - 6 p.m. This would provide a total of 30 channel hours per weekday, or 5 forty-minute


U.S.O.E.
AIT
Curriculum Materials
Research and Development
Delivers
Accredits
State Education Agencies
Local School Systems

Chief State School officers govern AIT, thus providing a means for state approval of nationally produced and delivered educational materials.

- --provide classroom space for viewing centers and CAI utilization
- --tutoring
- --administration
- --testing
- --certification of students

FIGURE 2

Organizational Framework for An Open Learning System
at the Elementary/Secondary Level

instructional segments for each grade 4 through 12. Inputs into the instructional mix would not necessarily have to be arranged into five 40-minute segments per day, but this calculation at least provides a basis for making a reasonable estimate of channel requirements. In a flexible open curriculum, the availability of this much television does not mean every student enrolled would utilize this much television every day. Other instructional tools and media would be available too.

2.4.2 Delivery Points

It is anticipated that both shared and dedicated delivery points would be utilized to serve elementary and secondary education. For those services which would not be delivered by public television, and in areas where there will be no public television outlets, terrestrial distribution would be through a combination of cable, ITFS, state-wide microwave hookups, such as the Indiana Higher Education Telecommunications System [15], and by direct distribution to low-cost receivers colocated with user facilities.

The ITFS, cable and microwave network delivery points would be shared facilities serving all educational sectors. The low-cost receivers would have to be capable of narrow-band return capability in order to take advantage of interactive services. They would need to be either dedicated terminals (i.e., terminals for use exclusively for elementary and secondary education services) or dedicated channels on multi-channel terminals. These terminals would need to be located in centers serving remote rural areas, probably schools, and in some urbanized areas without such local distribution facilities as cable. The number of these is extremely difficult to estimate.

As a basis for making such an estimate, this scenario assumes one delivery point for each of the 13,706 places classified as rural by the

Census Bureau and 1765 (or 25%) of the places classified as urban and not having cable service. [16] Combined, these figures come to 15,471. So a range of 15-20 thousand terminals with limited return capability is estimated, considering the possibility of multiple delivery points in urban areas.

It should be noted here that our assumption that 25% of urban areas will not be served by cable may be very optimistic, considering the slow progress of cable in the highly populated cities thus far. However, by Census Bureau definition, an urban place may have as few as 2500 people. When "urban" is defined in these terms, the 75% penetration figure becomes more plausible since it is the small cities outside the metropolitan areas that have had the most success with cable. It should also be noted that our hypothetical placement of a ground terminal in each rural place leaves unanswered the question of how satellite signals will be delivered to the end users. This would probably vary from place to place and might be expensive. Cable, district learning centers, or even low-cost receivers for direct satellite-to-home delivery may ultimately be the solution. In any case, it needs to be pointed out that the distribution system for delivering satellite signals to the end users in rural areas could constitute a substantial additional cost in an educational telecommunications system.

To reduce cost, placement of the terminals with return capability might be confined only to the most remote areas, the justification for doing so being that less remote areas would have access to better local services and would, therefore be less in need of interactive capability. The requirement for 2-way capability could be confined to schools in the 2500 most remote locations. As Stagl et. al. [17] have pointed out, if it were possible to confine the requirement for interactive terminals to one or two beam areas, for example, those including the Rocky Mountain and Appalachian territories, it would be possible to significantly reduce the total system cost. However, this scenario does not see the need for interactive capability as being confined to any specific geographic area, although Alaska is no doubt most in need.

Video receive/transmit terminals would also be required at a national repository for elementary and secondary materials (probably owned by AIT) and at several regional centers. The national repository would house materials for which production or delivery costs would be high enough that they need to be shared nationwide. The regional centers are shared facilities.

2.4.3 Summary of Channel and Delivery Point Requirements

Channel and delivery point requirements are summarized in Table 3. Two cases are considered: One in which 15-20 thousand limited two-way terminals are deployed; another in which 2,500 limited two-way terminals are used in conjunction with mostly receive-only terminals.

2.5 CAREER AND VOCATIONAL/TECHNICAL EDUCATION

The two terms, career education and vocational/technical education, are used to distinguish between two different concepts. Vocational/technical education is used to designate secondary and post-secondary training aimed at teaching a student the skills of a particular occupation he or she has chosen to pursue. Career education differs in that it is not occupationally specific. It is aimed at familiarizing the student with career options; preparing him to choose the options for which he is best suited; orienting him to job requirements and training opportunities; and providing information about finding employment.

As noted by Rothenberg [2], the prospects for using large scale

TABLE 3

Channel Requirements
for
Elementary and Secondary Education

2	full-time channels in switched-beam configuration for distribution of real-time instruction in traditional classroom applications and for distribution of delayed programs and teacher continuing education during evenings and weekends.
1	full-time channel in switched-beam configuration for CAI and narrow-band services.
3	channels 8 a.m. - 6 p.m. weekdays for Open Elementary and Secondary Curriculum.
6	TOTAL

Delivery Points

1 receive/transmit terminal for national center

Case #1: 15-20 thousand limited 2-way terminals.

Case #2: 12,500-17,500 receive-only terminals.
2,500 limited 2-way terminals or dedicated channels on shared terminals.

telecommunications seem brighter for career education than for vocational/technical education. This is so because the market for vocational/technical training is so fractionated, both in terms of type of training and sponsoring institutions, that it is difficult to conceive how it would be possible to assemble a single market large enough to justify use of large-scale telecommunications. The market for career education, on the other hand, is not so diversified, and a single unit of instruction can meet the needs of a vast audience. For example, a television program about opportunities in a certain career area or about how to select a good training opportunity would be appropriate for a large segment of high school seniors.

Career education is one area which broadcasting is well-suited to serve. It is informal instruction not requiring certification and can be pursued in the home as well as in school. There are no distribution channels better suited to reach the home audience, except perhaps cable when it reaches its potential. So this scenario anticipates that public broadcasting will be one major delivery system for career education. However, other systems are also likely to have an important role. Use of CAI (computer-assisted instruction) to familiarize students with career and training options has already been tried. In Illinois, a high school and college cooperatively sponsored the Computerized Vocational Information Service (CVIS). Remote terminals were connected to a central computer via telephone lines. [2] Satellite delivery of career education via computer based programming and other media was to have been given a major test during the ATS-6 demonstration in the Rocky Mountain region and Appalachia during the 1974-5 school year.

For the long run, this scenario foresees computer-assisted career education as a service available to every student either at home or at community learning centers. People in metropolitan areas with interactive cable systems will have access to locally stored career education libraries through terminals located either in the home or at an institution. Through these same terminals, students and adults alike will have access to a National Computer Job Bank being developed by the Department of Labor. As of 1971, job information was being compiled with computers and distributed to agencies in about 100 cities in printed form, micro-film or microfiche. This scenario envisions extension to on-line service. This service, which will be accessible through terminals located at employment agencies (public and private) will, according to this scenario, provide information not only pertaining to job placement but also pertaining to current job forecasts in various occupational areas and training opportunities. It is expected that this will continue to be a free service sponsored by the Department of Labor.

For everybody using the Department of Labor job bank service, distribution will be via satellite from centralized information banks in several regions. Each regional facility (according to the scenario, not necessarily Department of Labor plans) will be linked to a national facility in Washington, D.C., so that those needing information outside their region will be able to obtain it automatically.

As previously mentioned, career education CAI will be accessed locally in metropolitan areas with interactive cable. For those in rural areas, where career education is needed most, access will be obtained via satellite linkup to regional educational resource centers, which will serve several educational sectors. Development of this service depends on provision of satellite ground terminals with narrow-band return capability.

It is expected that PBS distributed television, the Department of Labor Computer Job Bank and CAI packages will be the basic commodities in the career education market. In all likelihood, career education CAI will be funded by the Office of Education, which will place great importance on the career education concept, as it does now. [18]

This scenario anticipates that additional television programming will be provided by regional public broadcasting networks and that CAI career education packages other than those most available through the Office of Education will exist; but, in terms of career education services requiring satellite channel capacity, what has been outlined constitutes the menu. Probably not much satellite capacity will be required; what little bandwidth may be required will probably be accommodated by riding piggy back on channels provided for other services. In the vocational/technical training area, it is easy to envision wide-spread use of technology, including ITV and CAI. As for technology applications making use of satellite distribution, however, the prospects appear bleak unless major new organizational structures not indicated by any current trend come about.

Proprietary vocational schools will no doubt use videocassettes. However, it seems doubtful that there would be a consortium of schools, unrelated by ownership, to share ITV programs distributed by satellite. If the trend toward group ownership of proprietary schools by large corporations continues [2], the possibility of satellite utilization seems greater. There are three major possibilities for assembling markets dispersed enough and large enough to justify satellite use:

1. Interconnection of military training centers for training in military occupations.
2. Interconnection of proprietary schools maintaining branches in several locations - a current trend.

3. Regional consortia of publicly-controlled vocational training centers funding and using media materials distributed from a central point, such as Project REACT, in which students learned welding via remotely accessed CAI. [2]

The channel requirements for both career education and vocational/technical training appear so limited, even for the long run, that this scenario does not call for any dedicated channels. Instead, it would seem more realistic to say satellite channel capacity will be needed regularly but in small quantities for CAI, especially in the career education area, and that video distribution by satellite will be occasional, with satellite channels being procured on a scheduled access basis.

2.5.1 Delivery Points

This scenario does not foresee a requirement for any dedicated uplink or downlink terminals. There would be a wide variety of delivery points, including schools, libraries, employment agencies, rural community centers, cable and ITFS headends; but it is expected that these would involve shared facilities.

Full 2-way uplink terminals will be required at regional resource centers and at entry points for such services as the Computer Job Bank, but these will be shared facilities.

2.6 HIGHER EDUCATION

Included in the higher education sector are two-year community colleges as well as institutions offering programs of study leading to baccalaureate and advanced degrees. Since continuing education is a separately discussed sector in this report, this discussion focuses primarily on "full-time" college study.. It is important to note, however, that this boundary between "full-time" and "part-time" programs is not always clear-cut and is likely to become even less so in the future. If current interest in the concept of "non-traditional" study is any indication of the future, then higher education is likely to become less tied to on-campus classroom attendance, less equated with credit hours and degrees, and less the exclusive province of the recent high school graduate.

It is perhaps with respect to the higher education sector that the greatest array of opportunities for the use of electronic technology and large-scale networking seems to exist. Instructional television was stressed in the discussion of early childhood education. Both instructional television and instructional applications of computers were seen as having possibilities in vocational/technical education, but opportunities for large scale networking were considered to be limited.

However, when one considers the concept of educational telecommunications networking and all the potential services (including televised instruction, teleconferences for students and educators alike, computer-based instruction, remote batch processing and interactive remote time-sharing for both administrative and research purposes, computer-based information storage and retrieval, and interlibrary services), the entire menu seems to make good sense for higher education.

Of course a note of caution should be sounded. Potential applications and actual prospects for implementation are two different matters. Like other sectors of education, higher education holds up major institutional barriers to the introduction of large scale telecommunications-based services.

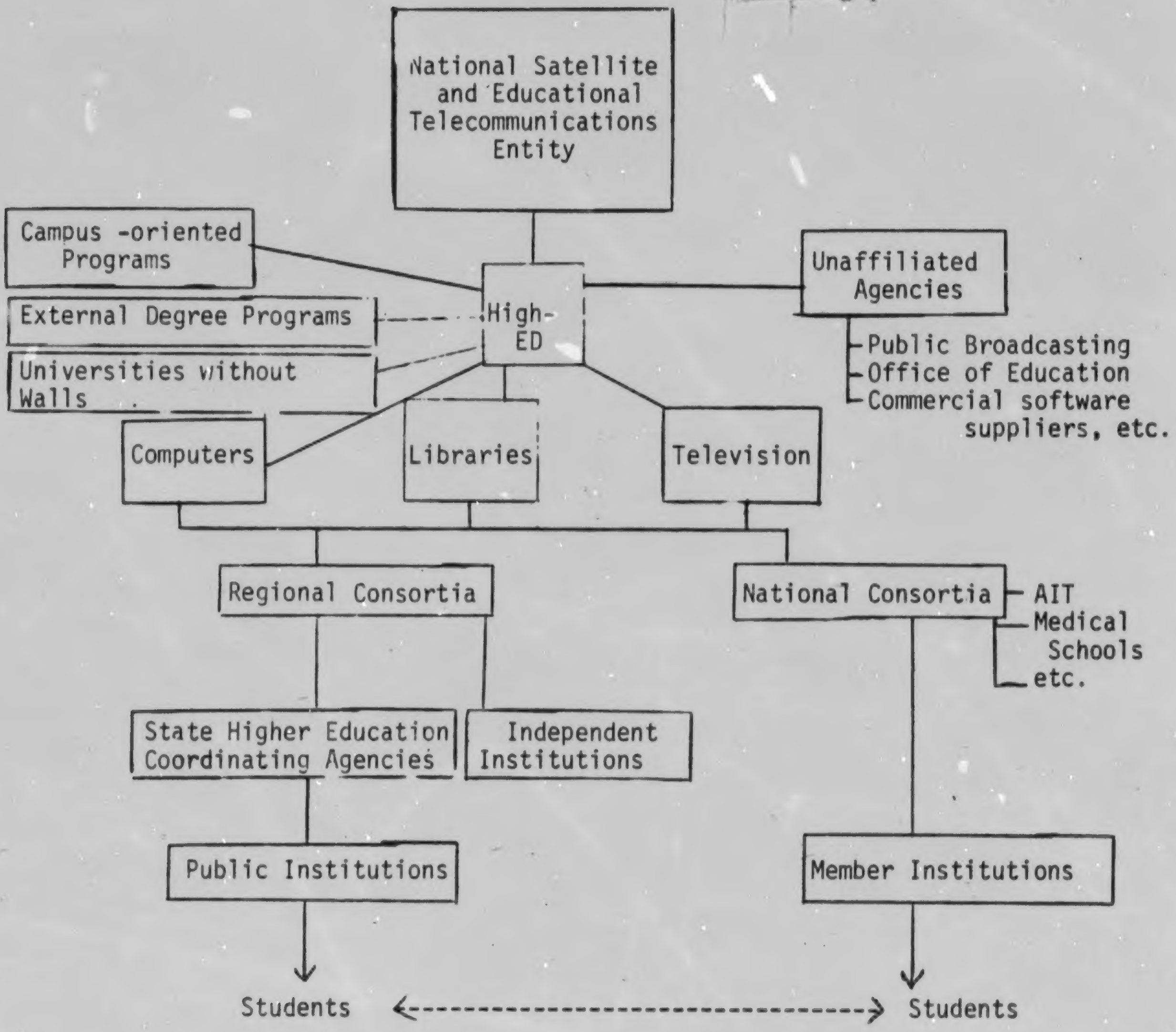
It is difficult to find a basis upon which to make even rough estimates of the number of hours of each kind of service which might eventually be utilized by higher education. Such estimates are only one of many types of information that would be needed in order to arrive at a realistic judgment about the requirements for satellite channels. Robinson's "Delphi" study [5] indicates "heavy"* utilization levels for higher education use of television in public institutions and homes by the year 1990 and, no less than "moderate" utilization for computer instruction and information services in public institutions, private institutions, and homes. An exception is computer instruction in the home, where only "developmental" status is indicated. Based on these study results, higher education seems to be a relatively promising sector for technology. New 2-year colleges, not tied to old ways of doing things, may be the most receptive to technology. [24]

Although a precise estimate of channel requirements is unachievable at this time, a good starting point is to break down higher education into subsectors. This will at least help to identify the users. Three major subsectors within higher education are represented in Figure 3: Campus-oriented activities, External Degree Programs, and Universities Without Walls. As illustrated, higher education use of satellites and other large scale telecommunications systems would be coordinated at the national level through an agency such as EDUCOM.** Although EDUCOM would appear to be one appropriate organization for this function, a new agency (HIGH-ED) could be substituted. The three major subsectors

---

*These utilization levels indicate the percentage of places making some use of a particular service, not the intensity of utilization. For example, "developmental" indicates 20-39% of places utilizing a service. "Moderate" indicates 40-59% and "heavy" indicates 60-79%.

**Interuniversity Communications Council - EDUCOM is a nationwide organization of universities, formed to facilitate collaboration among institutions in utilization of communications technology.


National Satellite and Educational Telecommunications Entity
Campus -oriented Programs
External Degree Programs
Universities without Walls
High-ED
Unaffiliated Agencies
Public Broadcasting
Office of Education
Commercial software suppliers, etc.
Computers
Libraries
Television
Regional Consortia
National Consortia
AIT
Medical Schools
etc.
State Higher Education Coordinating Agencies
Independent Institutions
Public Institutions
Member Institutions
Students
Students

Teaching institutions coordinate student contact, with certification being granted in the name of the institution with which student coordinates.

FIGURE 3

Organizational Framework for Large-Scale Telecommunications Services in the Higher Education Sector referred to above are 1) campus-oriented programs, 2) external degree programs, and 3) universities without walls.

For each of the subsectors, HIGH-ED might coordinate computer services, interlibrary communication services and instructional television. ITV might be coordinated by a higher education division of the Agency for Instructional Television consortium, which now focuses primarily on elementary education. Two basic types of inter-institutional cooperation could exist. Regional consortia such as the University of Mid-America, could facilitate cooperation among neighboring institutions within the same state or region, while national consortia would be concerned with cooperation among institutions sharing common needs and interests rather than common geography.

2.6.1 Campus-Oriented Programs

In this subsector, technology is to be incorporated into the traditional campus setting for pursuing a college degree. Telecommunications can be used in education to expand access to services, to individualize and increase the flexibility of education, to deliver non-traditional services, and to effect cost reductions through resource sharing. [1] For the campus subsector, the emphasis is on the resource sharing aspect of networking.

Interconnected institutions of higher learning could teach freshman math, chemistry or other courses with one rather than several instructors per course. There is a good deal to be said in favor of each institution presenting each course in its own way in order to preserve diversity in our system of higher education. However, the other side of the coin is that telecommunications can increase diversity for many smaller institutions who can afford only one instructor with one approach for each course or who cannot afford to teach some courses at all. In addition to telelectures, regional computer and library networks can be brought about through low cost telecommunications.

Any scenario for the development of telecommunications services for traditional, campus-oriented education should take into account the existing institutional structure of higher education. Given the autonomy of each institution, which is the prevailing structure today, it is reasonable to expect the first area of cooperation to be among the several branches of multi-campus universities and among public institutions within the same state. For example, state institutions in Indiana are interconnected by the Indiana Higher Education Telecommunication System. [15] Wong has documented a sizable amount of such activity [43]. Later, cooperation would be among neighboring public and private institutions and, finally, among institutions scattered throughout the country. According to Wong's investigation, directors of technology based networks at large state universities are receptive to expanded cooperation. [43]

As for the order in which various telecommunications services might take hold in campus-oriented higher education, it is expected that earliest cooperation will come in supportive areas rather than in instruction itself. The major support areas are computer resource sharing and interlibrary cooperation. Because of the perceived threat to faculty security, institutional jealousy concerning curricula, and the difficulty of scheduling cooperative distribution and utilization of telecommunications-based instruction (primarily ITV), cooperation in instruction will probably come more slowly.

This scenario foresees two basic avenues of cooperation among institutions. One approach is consortia of schools organized along geographic lines, both state and regional. The other approach is consortia of schools located in scattered, non-adjacent areas. For example, a small private liberal arts college in Missouri may have more in common with a similar school in Ohio than with a large state university in Missouri. In addition, cooperation on a national level will likely be facilitated by a higher education division of the Agency for Instructional Television or by regional organizations such as the University of Mid-America.

Pre-produced instructional television or CAI packages will not be the only instructional applications of telecommunications. Both regional and national teleconference hookups will be facilitated by the availability of low cost satellite interconnection.

Channel Requirements

There is no firm basis for estimating the number of satellite channels that might eventually be utilized for campus-oriented services in higher education. Still, one task of this report is to illustrate the potential markets for satellite service, and to provide some estimate of the requirements of a satellite system to serve those markets. Therefore, Table 4 shows how a possible requirement for 4 satellite channels may be developed. A great many assumptions were made, but an effort has been made to keep the assumptions within the realm of plausibility.

Delivery Points

The nation's colleges and universities could be linked into a satellite system in a number of ways. A good many may be linked to satellite earth terminals located at CATV headends. These multi-channel terminals would serve multiple educational sectors. For purposes of this report, the assumption is made that 500-750 colleges and universities will not have access to such shared terminals and will require dedicated

TABLE 4. Satellite Channel Requirements for Campus-Oriented Higher Education Services

1. Nine million full-time equivalent students. [23]

2. One full-time equivalent teaching faculty per 30 students*

   → 300,000 faculty members.

3. Two course sections taught per semester (1 during Summer) per faculty member.

   → Seven sections per faculty per year

   → 2.1 million sections per year.

4. $\frac{2.1\text{ million}}{3}$ = 700,000 sections taught at more than one university and scheduled at approximately the same time; hence, good prospects for at least partial delivery via large scale telecommunications system.

5. "Average" course section utilizes 2 satellite video channel hours in a semester.

   → U.S. colleges served by 1.4 million satellite channel hours per year.

6. Average number of institutions sharing a channel hour is 12.

7. Total channel hours of service required: $\frac{1.4\text{ million}}{12} = 116,666$

8. Distribution is 24 hours, 300 days, 7200 hours.

9. Total channels required: $\frac{116,666}{7,200} = 16+$

10. Each channel simultaneously available in 4 separate beams covering the U.S.

    → actual required channels for campus oriented services = $\frac{16}{4} = \underline{4}$.

---

*The Carnegie Commission on Higher Education estimated a student population of 16 million by the 2000, with a student-to-teacher ratio of 19 to 1. The considerably lower estimate of student population used here is based on Office of Education Projections for 1980 and includes only full-time equivalent students. One justification for using the lower (Office of Education) figure is the belief that greater numbers of students will move into external degree programs and "university without walls" programs. Higher student-to-faculty ratio is used to account for faculty whose major responsibilities are research rather than teaching oriented and to account for the belief that those courses which lend themselves to large scale delivery systems will be courses which tend to have higher student-to-teacher ratios. It should be added that since this estimate was made, estimates of student populations have continued to fall.

terminals. To facilitate interactive services, these terminals will need to have at least narrowband return capability.

At least one video transmit/receive terminal would be required for a national Agency for Instructional Television center for higher education. Others will be needed at regional resource centers, but it is expected these would be multi-purpose centers serving numerous educational sectors. There has been some discussion of a national network for the education of health science professionals, a project which has been under study by the National Library of Medicine and the Association of American Medical Colleges. [22] Such a network would probably require a limited two-way terminal at most medical schools and dental schools. In addition, full two-way capability would probably be required at one national resource center and several medical schools which would serve as regional "hubs". Should such a health science education network come about, an additional dedicated satellite channel would seem a reasonable requirement.

In sum, the satellite channel and dedicated earth terminal requirements of a system to provide campus-oriented services for higher education are as follows:

Channels: 4
+1 for health sciences education network.
5

Dedicated earth terminals:

Full two-way --- 1 for AIT higher education center
7 for health sciences education network
8

Limited two-way --- 500-750

Receive-only --- 0

2.6.2 External Degree Programs

The "external degree" category is similar in concept to the Open University [19] in Great Britain in that traditional-type services can be delivered, partly by telecommunications, to the student in an off-campus setting such as the home. There are anticipated differences, however. First, there will be not one, but numerous "open universities" operated on a regional or state basis. Second, the problem of accreditation militates in favor of open university programs sponsored by existing institutions of higher learning rather than autonomous open university systems. However, semi-autonomous external degree systems under the jurisdiction of established state higher education authorities will also emerge, as in the cases of the Empire State College in New York or the State University of Nebraska. A report of the Commission on Non-Traditional Study [20] discussed the concept of a National University which would award degrees in its own name but which would not itself offer any instruction. The National University discussed, but not recommended, by CNTS, would function as a registry of educational experiences accumulated by students and could award degrees jointly with teaching institutions as well as in its own name.

In order to find wide acceptance, telecommunications-based sharing among universities for campus-oriented applications would very likely have to be distributed through dedicated channels rather than through PBS. The more control that can be maintained over scheduling, the greater the chances of success. But the external degree concept is different.

Although the fact that public broadcasting is not basically an educational institution works against an organization like PBS being the sponsoring agency for a degree-granting open university system, this scenario does see a possible distribution role for public broadcasting.

One function of the administrative arms of external degree systems will be to procure whatever distribution channels are most efficient for a given task. Distribution for the televised portion of a given course would be accomplished by a variety of means, including regional broadcasting networks on a contract basis, leased satellite channels, and leased local distribution channels, such as cable and ITFS. The best available delivery system will vary by area.

It is assumed that students enrolled in external degree programs will finance at least as large a portion of the cost of the service as they do for on-campus instruction. Bowen [20] has speculated that instruction distributed through free access mass media channels, such as public broadcasting, would need to be subsidized, since it would not be fair charging only credit seeking viewers at the point of granting credit, while not charging anything to participants who do not seek credit. However, if televised instruction constitutes only a relatively small portion of the external degree curriculum, as is the case with Great Britain's Open University, [19] the free-loading factor would appear to be minimal; and it would be preferable to let the curriculum pay its own way, with charges being assessed at the point of delivery for non-mass media services and at the point of credit. This scenario envisions CAI, personal tutoring and printed materials as being significant inputs to the external degree curriculum.

While this scenario envisions regional and state external degree programs rather than a single national Open University, satellites would make it possible for a major university to sponsor an external degree program enrolling students from throughout the country. As shown in Figure 4 such a program could incorporate local services by contracting for the services of qualified tutors and counselors in various parts of the

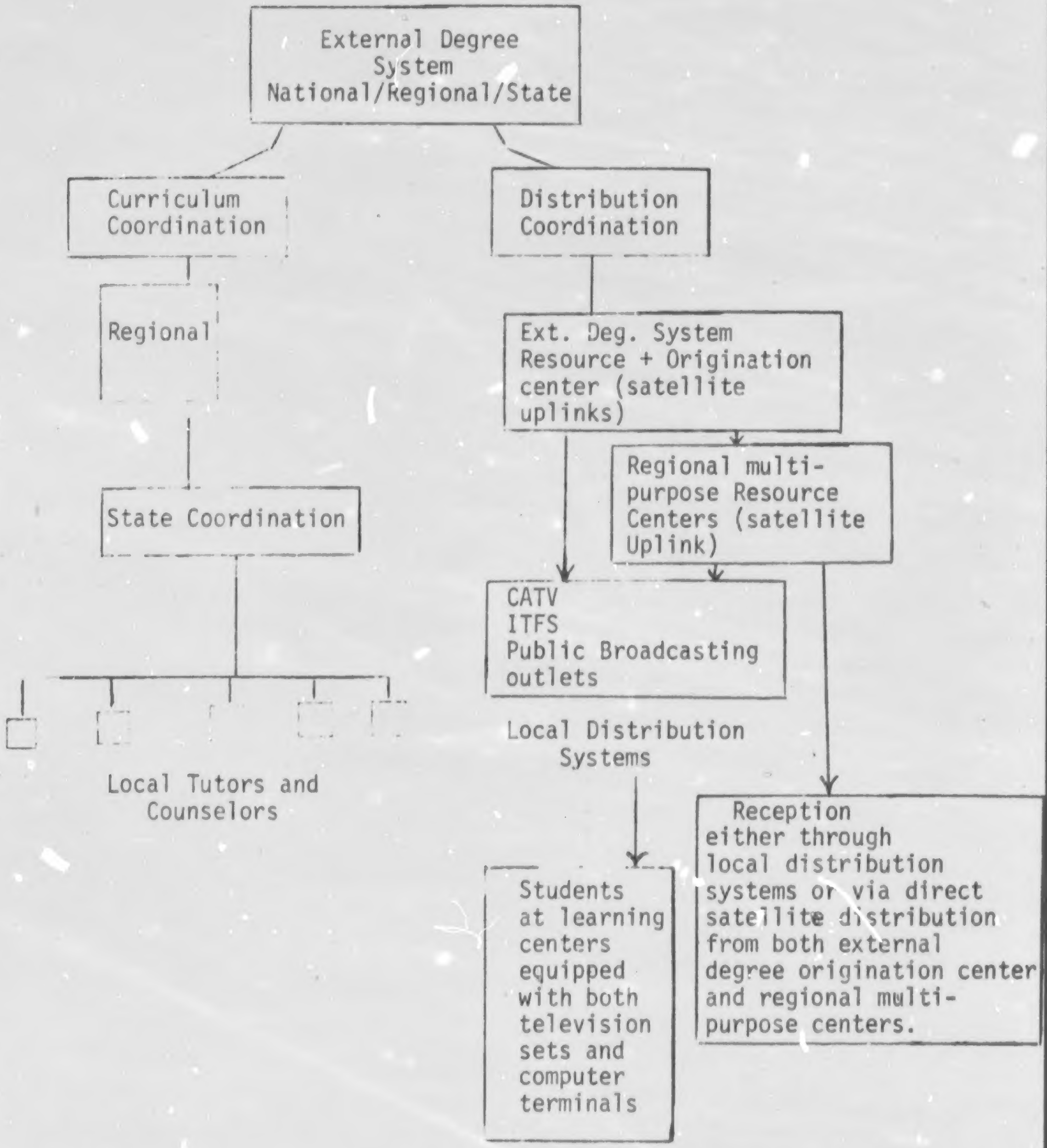

External Degree System National/Regional/State
Curriculum Coordination
Distribution Coordination
Regional
Ext. Deg. System Resource + Origination center (satellite uplinks)
Regional multi-purpose Resource Centers (satellite Uplink)
State Coordination
CATV
ITFS
Public Broadcasting outlets
Local Distribution Systems
Local Tutors and Counselors
Reception either through local distribution systems or via direct satellite distribution from both external degree origination center and regional multi-purpose centers.
Students at learning centers equipped with both television sets and computer terminals

FIGURE 4

Structure of External Degree Systems

country and by contracting for use of CAI terminals and other computer facilities wherever students may be located.

Channel Requirements

So far, the external degree concept in the U.S. is in the early development stage. Ascertaining satellite channel requirements is not possible without knowing how many external degree programs will eventually develop, what instructional components will be involved, and the extent to which large scale telecommunications based delivery systems can be used.

Nevertheless, it seems realistic to expect that the open university or external degree concept will become increasingly popular and that both mass media and CAI (for individual instruction) will be important components. In a switched-beam satellite configuration, two satellite channels could be used to deliver several hours of instruction simultaneously, eight hours in the case of a 4-beam configuration. A channel might be used entirely for television distribution, or a large number of students might simultaneously use a channel to interact with a CAI program stored at a regional resource center.

It is possible that external degree programs could eventually require more than two channels, especially if they are predominantly coordinated on a state rather than regional level. However, if one conservatively assumes that telecommunications services will constitute only a fraction of the external degree delivery system, it then seems reasonable to assume that two channels could accommodate the needs of several or more external degree programs.

Assuming the mass media portion of the delivery system would be utilized on a real-time basis, rather than recorded for later use, (a realistic assumption, given that students will be in homes or other off-campus settings) it seems reasonable to say that the heaviest use of the channels would be in daytime and evening hours and that overnight use of the channels could be made by another educational sector, perhaps for campus-oriented services, elementary and secondary education and other classroom-based services. These are areas in which the "record for later use" mose of distribution would perhaps be more suitable, because the cost of record/playback equipment can be spread over many users.

Delivery Points

The assumption made here is that the requirement for satellite earth terminals would be roughly equivalent to that stated for the elementary and secondary education sector, since the "external degree" services will need to reach many of the same off-campus settings, such as rural schools or community centers. PBS may be able to handle some, but not all of the delivery of "external degree" services. Most video distribution in external degree programs would be non-interactive, but interactive capability would be required for CAI activities. In urban areas, most distribution would be through such local distribution channels as cable rather than via direct reception. So the requirement for dedicated terminals with limited return capability is assumed to be 15-20 thousand. This would cover rural places and the 25% of urban places assumed not to have cable service. As in the case of elementary and secondary education, the authors recognize that an assumption of 75% of urban places served by cable is optimistic. However, the extent of cable development in the U.S. may be an indicator of just how favorable the climate is for educational telecommunications, including satellites.

In addition, a requirement for one video uplink at each external degree resource/origination center is assumed. If ten major external degree programs exist, then ten full two-way terminals are required.

2.6.3 Universities Without Walls (UWW)

The "UWW" label is used here to refer to an approach to education rather than to the actual consortium of colleges bearing the UWW name. The important element in the UWW concept is that a student and his counselor piece together a program specifically tailored to meet the needs and interests of the student. This is in contrast to the traditional approach in which degree programs are mostly pre-structured for the student. Educational experiences for which degree credit may be granted might include employment experience, on-campus courses, independent study, or any other endeavor which would contribute to the student's intellectual development.

The role for large scale telecommunications networking in the UWW approach is difficult to assess. Since the very nature of large scale telecommunications is service to assembled mass markets, the UWW concept, wherein each student's program is unique, appears to be incompatible. This scenario does not envision services being created specifically for UWW students, who may be a growing portion of participants in the higher education system, given the need for more flexible curriculum content and delivery. Instead, it is envisioned that UWW students will participate on a selective basis, in the telecommunications network services provided to campus-oriented and external degree students.

To facilitate this participation, a National Inventory of Learning Resources, already proposed in connection with the existing UWW [21] will be implemented. A remotely accessible computer-based catalog of learning resources, including those provided over telecommunications facilities, will assist the UWW student and his counselor in planning a good academic program.

Channel Requirements

There is no basis upon which to estimate how many satellite channels would be required to serve the need of UWW students. But since the telecommunications services in which UWW students would participate would probably be those already provided for campus and external degree students, no additional channel requirements are anticipated at this time. Neither is there an expected need for additional satellite earth terminals. This is not to imply an unimportant role for telecommunications. The lack of additional requirements is due to the fact that access points and delivery systems for UWWs will overlap with those for other higher education services.

2.6.4 Summary of Channel and Delivery Point Requirements for the Higher Education Sector

Channels:

Campus-oriented services	4 full-time
Health Sciences Education	+1 full-time
	5 full-time
External degree programs	2 full-time
Universities Without Walls	0 full-time
TOTAL	7 full-time channels

Delivery Points (Earth Terminals) - dedicated only

Campus-Oriented services	
Full two-way capability	1 AIT Center
	7 Health Education
	8
Limited 2-way	500 - 750 Campuses not linked to Cable
External Degree programs	15 - 20 thousand rural areas without cable

(continued on next page)

Full 2-way Capability	10
Limited 2-way (or dedicated channels on shared terminals)	15 - 20 thousand
Universities without walls	0
TOTALS:	
Full 2-way capability	18
Limited 2-way	15,000 - 20,000

It should be noted that this discussion has said little about the specifics of computer and interlibrary networking services. Of all the educational sectors, higher education seems most likely to exploit the potential of these services.

Computer and library information networking do not constitute an educational sector in the same sense as early childhood education or higher education. But they do represent a major market for telecommunications services, and they traverse the boundaries of all the specific sectors discussed in this report. Rather than discuss computer and library interconnection for each sector, a separate section discusses computer-library networking as a whole.

2.7 ADULT EDUCATION

Adult education is a broad area which includes several subsectors. Among these are:

Adult Basic and Compensatory Education --

Designed for out of school individuals 16 years of age and over who lack eighth grade proficiency in basic academic skills (Adult Basic Education) or who have not completed at least the equivalent of a high school education [2].

Continuing Career Education --

"Refresher course" type of education designed to keep working adults abreast of new developments in their occupational areas. Also includes so-called "job retreading" for individuals whose occupations become obsolete.

Continuing Professional Education --

"Refresher course" type of education for the professions, such as medicine, engineering, teaching, law and management.

Continuing Informal Education --

Includes education undertaken for personal satisfaction rather than for career reasons.

Continuing Formal Education --

Education pursued for personal reasons, but differing from informal education in that it is more likely to take the form of structured classroom-type courses, rather than the more leisurely type of educational programming frequently seem on public television.

"Lifelong" education is a concept come of age due to rapidly changing employment patterns and job requirements and due to vastly increased amounts of time available to pursue education, both during and after the working years.

2.7.1 Delivery Systems

The delivery system requirements in adult education vary for each of the subsectors named above. The key distinction is in the extent to which each subsector lends itself to delivery via a mass media system like public broadcasting.

It is anticipated here that public broadcasting can and will play the primary delivery role for adult basic/compensatory education and for continuing informal education. For continuing career/professional education and continuing formal education, on the other hand, public broadcasting is not seen as a major delivery system.

There are two main criteria for determining the suitability of public television. First is the matter of whether the field is homogeneous enough to warrant a mass media approach. For example, a single series of programs teaching a basic reading or math skill can probably be used to reach the major share of the 46.5 million adults 25 years of age and older who lack a high school diploma [26]. Medical doctors, on the other hand, are a smaller population to begin with, keep different schedules, and are diversified into dozens of specialties, each requiring continuing education services.

A second criterion is whether or not the training must be accredited and the recipients of the training certified. It has been a contention (an admittedly debatable one) throughout this collection of scenarios that educational programs requiring such certification are best coordinated and distributed by educational agencies with established credential-granting authority rather than by a broadcasting organization such as CPB or PBS.

The required satellite channel capacity and delivery points for the adult education sector can best be estimated by exploring each sub-sector separately.

2.7.2 Adult Basic and Compensatory Education

Figure 5 illustrates the basic organizational structure for delivery of service in this area. Two major programs cosponsored by the Office of Education and the Corporation for Public Broadcasting are envisioned, with the Public Broadcasting Service and U.S.O.E. being the agents of actual implementation.

Organizational Structure for Telecommunications Delivery of Adult Basic and Compensatory Education Services

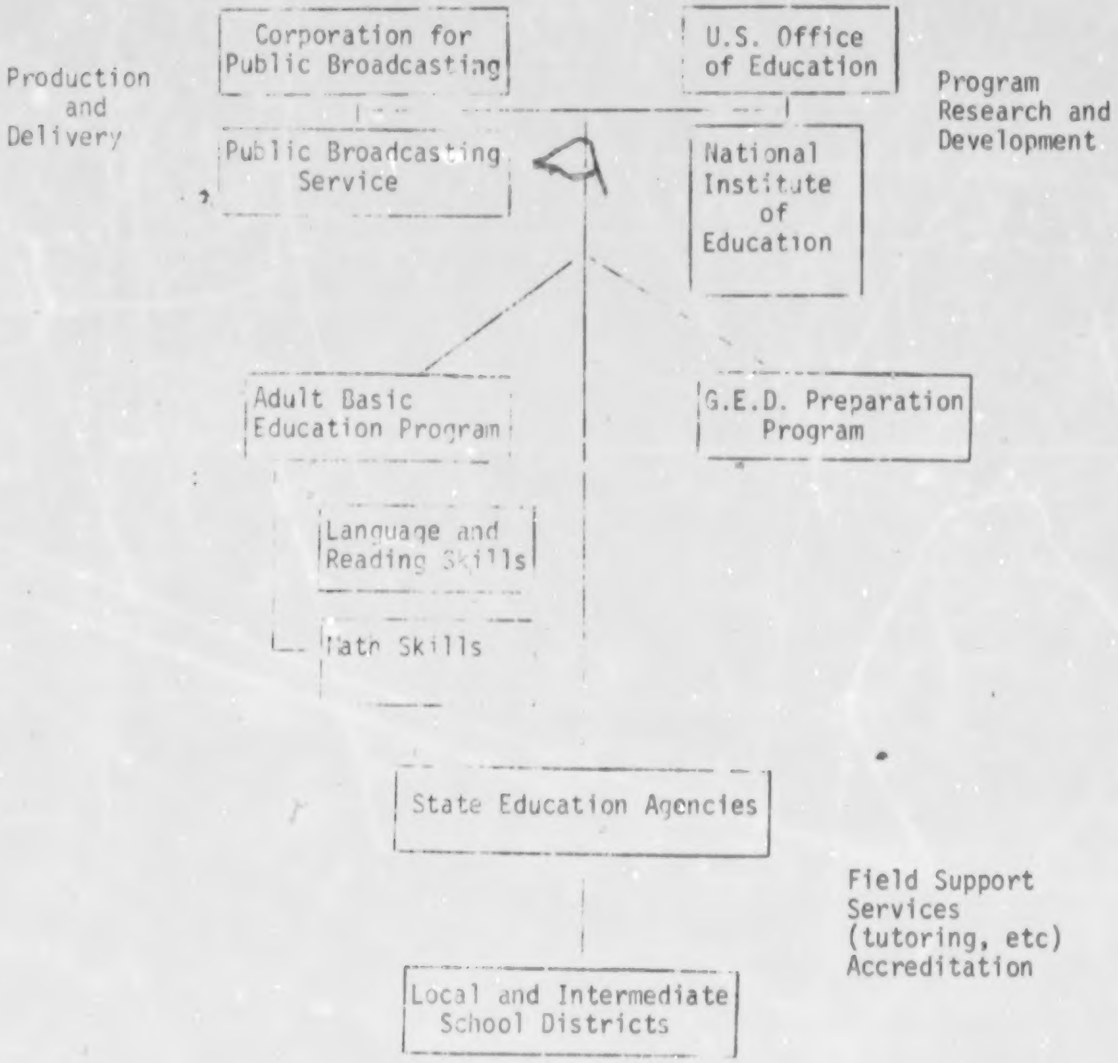

Corporation for Public Broadcasting
U.S. Office of Education
Production and Delivery
Program Research and Development
Public Broadcasting Service
National Institute of Education
Adult Basic Education Program
G.E.D. Preparation Program
Language and Reading Skills
Math Skills
State Education Agencies
Field Support Services (tutoring, etc) Accreditation
Local and Intermediate School Districts

Figure 5

The two major programs are a G.E.D. (General Educational Development) high school equivalency test preparation program and an Adult Basic Education program to equip school dropouts with fundamental reading and math skills required to function in a job, but not necessarily to prepare them for the high school equivalency exam. The latter is very similar to the Project STRIVE program once planned, but later cancelled by CPB.

PBS coordination of the G.E.D. preparation program is an exception to the general rule that credentials-generating programs should not be coordinated by a broadcasting agency. Here, the program need not be accredited, since completion of the program would not in itself earn a high school diploma or its equivalent. The program would merely prepare participants for the high school equivalency examination, which would continue to be sponsored by an independent G.E.D. organization, with standard G.E.D. tests being administered by local high schools.

It is expected that both programs, like STRIVE, would utilize print materials and personal tutoring and counseling services in addition to a heavy broadcast input. These local services would be coordinated by state agencies which, in turn, would work with local school districts.

Since the scenario laid out for public broadcasting anticipates a role for public broadcasting in the delivery of adult basic education services, it is not necessary to add any additional usage for each of the two adult basic education programs (reading and math) and the G.E.D. program would be roughly equivalent to what had been planned for Project STRIVE. That program called for 35 hour-long and 30 half-hour national television programs. [2] The schedule might conceivably be expanded to two hours per week for each of the three programs. If a PBS service is expanded by a second channel, the total reach of the G.E.D. program could be increased through repetitive broadcasts. This would depend on how much of its schedule PBS would be prepared to allocate to the service.

The delivery system is to be public television, so the delivery points would be the public television outlets previously accounted for, with the final delivery point being the home television sets or community learning centers which would be shared with other educational sectors. For areas not served by public television outlets, these community learning centers would be both the initial and final delivery points.

2.7.3 Continuing Informal Education

Public broadcasting already serves as an outlet for a good many informal educational services, and it is expected public broadcasting will expand its role in this area. Unlike the adult basic education programs discussed above, however, informal educational services will continue to be delivered in many ways, from local school system "enrichment" programs to videocassettes in public libraries to self-administered reading programs.

As with adult basic education, no additional requirement for delivery points or satellite channel capacity is foreseen.

2.7.4 Continuing Formal Education

Like continuing "informal" education, continuing "formal" education is pursued for reasons of personal satisfaction rather than to acquire any official credentials. Like "informal" education, it will be pursued in many different ways, with no single organizational framework encompassing all activity in this area. In this scenario, all activity in the continuing formal education area which involves satellites would be related to sectors already discussed, primarily higher education. Therefore, no additional delivery points or satellite channels will be required to serve this subsector.

2.7.5 Continuing Career Education

Few would question the need for employed adults to engage in some form of continuing training in order to keep up with the times in matters related to their jobs. In some cases, entire job areas will no doubt become obsolete, and the adult will find himself or herself in need of preparation for a new career.

The role of satellites in this is, of course, very uncertain. The role may be very limited. Three areas of possibility seem worth mentioning. First is the possibility that some educational programs delivered via public television may be useful in the area of continuing career training. For example, a series on human relations may have broad enough appeal that PBS would consider including it in the program schedule. If not PBS, state and regional public broadcasting networks might. Viewing places might be either in the home or on the job. In any case, no additional channel or delivery point requirements would result.

A second, and very real possibility is that colleges and perhaps even vocational training centers would contract with corporations to deliver certain kinds of training to plants via television or via CAI. In the case of CAI, certain programs stored at regional resource centers might very well be utilized at corporate plants equipped with the necessary terminals. Such joint efforts between university and corporation have already been undertaken at Stanford and in a number of other universities in the area of continuing professional education for engineers [43]. It may be that a university might serve corporations located outside the campus vicinity if satellite channels were available. Delivery to students in states outside the state in which the university is located might require the university to obtain charters in those states.

Industry has demonstrated stong interest in the use of television and other media for employee training. [27] If low-cost satellite transmission were available, it would not be surprising to see materialization of still a third possibility -- use of satellites for interconnection of multiple-plant corporations for training and employee motivation.

Should these possibilities develop, it is doubtful that dedicated satellite channel capacity would be required. If 50 of the larger corporations were to utilize an average of 5 hours of satellite channel capacity per month, the total satellite requirement would come to 250 channel hours per month. This estimate is on the cautious side but is based on the guess that corporate training centers are likely to make greater use of such demand access technologies as videocassettes than large scale systems like satellites. Possibly, corporations could use dedicated channels for business traffic other than training, but assuming training to be the only traffic, satellite capacity would probably be procured on a scheduled access basis from idle channels used by other educational sectors.

Although no additional channel requirement is foreseen, each of the 50 corporations might desire delivery points of the limited two-way variety. Assuming an average of three use locations for each corporation, the additional requirement would come to 150 limited 2-way terminals.

Since each corporation's need for access to a satellite uplink would be infrequent, and since there is a good possibility that several of the corporations would be located in the same geographic area, it is assumed that a dozen full 2-way terminals* would be adequate. There is a possibility of major corporations forming a consortium for ownership of such terminals located at strategic points around the country.

2.7.6 Continuing Professional Education

The concept is the same as for continuing career education, except that as it is defined here, it is confined to specialists in the fields of medicine, teaching, law, engineering and management. Engineering and management personnel who would be most likely to use large scale telecommunications might very well be employed at the same 50 corporations that would use telecommunications in training other personnel. If so, the additional requirements for delivery points, if any, would be minimal.

One distinction of people in most professional areas is that they receive above average incomes. This raises the possibility of professionals paying their own way for continuing education other than that provided by employers. A marriage of satellite technology and pay cable could facilitate development of user-supported educational services. Such services may eventually be provided either by private entrepreneurs or through a special revenue generating division of the public broadcasting system.

In addition to engineers and managers, teachers and medical specialists have been included in the professional area. Final delivery points might be in medical offices, hospitals, universities and community learning centers. With the exception of hospitals and medical offices, these delivery points have been accounted for in discussing other sectors. Although medical offices would be delivery points, it is unlikely that they would be satellite delivery points, except in the case of a direct-to-home broadcast satellite system, which is not expected in the near future. More likely, services would be relayed from satellite delivery points to medical offices via local distribution channels; e.g. cable.

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*By "full 2-way terminals," is meant interactive terminals capable of sending as well as receiving video transmissions.

It is important that medical personnel and teachers in isolated areas, especially Alaska, have access to continuing education services. This scenario foresees significant, publicly subsidized efforts to reach these individuals. Health care experiments, using the ATS-1 satellite to link medical paraprofessionals in Alaska with medical specialists in the continental U.S. have already been conducted under sponsorship of the Lister Hill National Center for Biomedical Communications. [28] Using the same satellite and relatively low cost earth terminals, the National Education Association and University of Alaska have offered a seminar course for Alaskan village teachers. Although the program was heavily subsidized by free access to satellites and earth terminals, enrolled teachers did pay a tuition fee of $18.

It is expected that additional earth terminals or additional channels on shared community terminals would be required to serve these geographically isolated professionals and to serve hospitals and medical centers located outside areas served by cable. The nature of training for these groups would likely involve both CAI and teleconference-type formats. Therefore, the terminals would need to be of the limited 2-way type. The assumption is made that 2500 of these terminals might be required for hospitals and medical centers.

This scenario envisions a national instructional resource center for continuing teacher education, for which a full 2-way video terminal would be required. The center would distribute its resources both directly to such special need areas as Alaska and to regional resource centers for delayed distribution. The probability of continuing education for teachers is more likely than a telecommunications program to train new teachers in view of the teacher surplus situation and existing graduate teacher training institutions.

It is expected, according to this scenario, that most teacher education will require accreditation. Because of this, continuing education for teachers will be organized and distributed on a regional basis by consortia of state education agencies and accredited teacher training institutions. States will more likely accredit programs which they sponsor than they will accredit programs initiated by an independent organization.

No additional uplink requirement is foreseen for distribution of medical education materials, since the facilities of the health sciences education network discussed under "Higher Education" would suffice.

2.7.7 Satellite Channel Requirements

According to the scenario, public broadcasting would be the primary delivery system in adult basic education and no additional channels would be needed. In the continuing "formal" and "informal" education areas, public broadcasting and higher education have previously been allocated the channels required. In both these areas, several delivery systems would develop, but the only ones involving satellites will be organized by the public broadcasting and higher education sectors.

The sponsoring agencies for continuing career and professional education, whether employers, educational institutions or regional consortia, would need access to satellite channels from time to time. No precise estimate of the channel hours which might be consumed by these subsectors can be made at this time. However, it is expected that dedicated full-time channels would not be required. Instead, it is expected that channel time would be procured on a scheduled access basis from idle hours on dedicated channels serving other sectors.

In sum, the satellite channel and dedicated earth terminal requirements for service to the adult education sector are as follows:

Channels: Procured on scheduled access basis. No dedicated channels.

Dedicated earth terminals:

Full 2-way -- 1 for National Instructional Resource Center for Continuing Teacher Education

Limited 2-way -- 150 located at corporated locations for continuing career/professional education

Limited 2-way -- 2500 located at hospitals and medical centers without access to cable.

Receive only -- 0

2.8 SPECIAL EDUCATIONAL MARKETS

A number of educational subsectors can be included under this heading. They can be called "special"* either because they require a distinctive approach in content and delivery of conventional educational services such as elementary and secondary or higher education, or because they require unique educational services that are unrelated to the conventional categories.

The list of these potential submarkets is rather long and includes ethnic and linguistic groups; people in isolated regions; elderly citizens; institutionalized groups, such as residents of nursing homes and correctional institutions; handicapped citizens; and the military.

Three of these many groups are discussed below. In choosing migrants, the prison population and handicapped children for discussion, we have selected what we consider to be groups with important special needs that can be met to some extent through large scale telecommunications networking. However, this is in no way meant to suggest that the needs of the other groups are any less important. For example, work by Johnson [53] and Holden [54] has set forth the need and rationale for a telecommunications network controlled by and geared to Black Americans. The needs of geographically isolated and rural groups, who are currently underserved by telecommunications, are also very important and will be addressed in Section 3.2 which includes a description of a satellite system designed to extend educational television to rural and isolated areas.

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*We do not mean "special" in the same sense that the phrase Special Education is more commonly used in education, that is, education for handicapped children.

2.8.1 Migrants

The migrant farm population in the United States numbers about 1.4 million, including 330,000 migrant preschoolers.* [29] This population is confronted with some critical educational needs and problems, including the following:

1. Educationally deficient migrants need access to fundamental knowledge essential to living in our society. Major areas of deficiency are personal health education and English language training.
2. Career and vocational education is needed to enable migrant workers to abandon migrant work for more permanent employment. As farms mechanize, employment opportunities for migrants decline.
3. Migrant youngsters need access to early childhood care and education in order to avoid "slipping behind" during the critical early development years.
4. School-age children of migrants move from state to state with little hope of any kind of continuity in their educational development. There is little continuity of either curriculum or records of achievement.

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*A more recent (1975) study containing information about educational needs and telecommunications projects involving migrants and American Indians has been completed by Perrine. [49]

This scenario envisions development of a national telecommunications program to deliver educational services to migrants. The program will be part of a total educational telecommunications system and part of a larger package of services to migrants.

Figure 6 shows the basic structure of the migrant telecommunications program. Although heavily funded and organized by the Office of Education and Department of Labor, there will be strong representation of states in governance of the program. According to the scenario, there will be a national Migrant Education Resource Center, supplemented by three regional Migrant Educational Resource Centers. The national center will provide services suitable for all migrants, while the regional centers will serve the unique needs of the populations of three major migrant streams. [29] The Western resource center will serve the migrant stream that moves up the West coast from the southern part of California. The Central resource center will serve the stream that follows the crops through the mid-continent areas from Texas, and the Eastern center will serve the stream that moves up from Florida along the east coast. The California and Texas-based streams consist mainly of Mexican-Americans while the Florida-based stream is mainly Blacks, Whites and Puerto Ricans.

Each of the three major streams will come under the jurisdiction of a separate multi-state consortium, which will provide for inter-state cooperation in developing a common curriculum to follow migrant primary and secondary students through their seasonal travel patterns. The basic concept is that when a student moves, he will be able to pick up exactly where he left off when he arrives at the new destination. Each consortium will be authorized to grant school credit and diplomas jointly with the school district in which each student spends the greatest part of the year, which will already have accreditation from a recognized regional accrediting

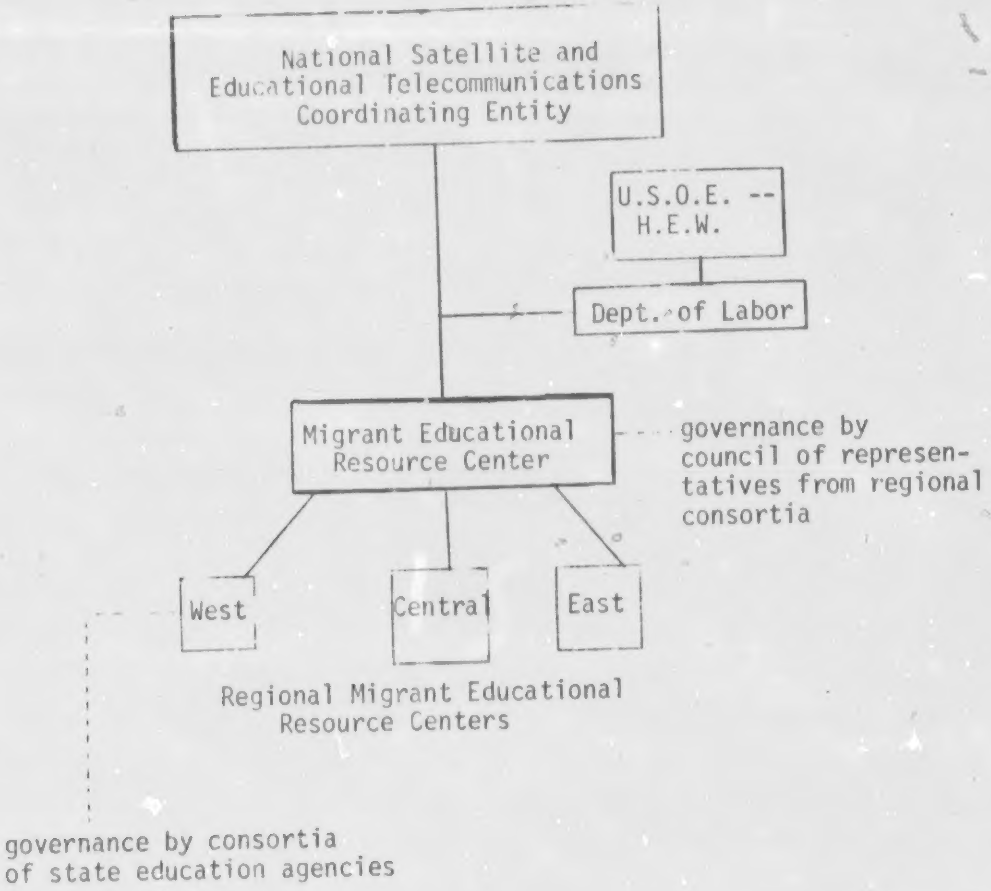
National Satellite and Educational Telecommunications Coordinating Entity
U.S.O.E. -- H.E.W.
Dept. of Labor
Migrant Educational Resource Center
governance by council of representatives from regional consortia
West
Central
East
Regional Migrant Educational Resource Centers
governance by consortia of state education agencies

FIGURE 6

Structure of Telecommunications

Program for Migrant Education.

agency.* The foundation for building this cooperative framework can perhaps be found in three interstate compacts in the educational field: The Southern Regional Education Board, the Western Interstate Commission for Higher Education, and the New England Board of Higher Education. [29] These specific organizations may not be appropriate but they at least show that interstate educational cooperation can take place.

Although a good share (up to half) of the curriculum will be provided through instructional television or computer-assisted instruction, the curriculum will have teacher-oriented classroom components also. The delivery system for the ITV and CAI components will be dedicated satellite channels delivering to both mobile and fixed migrant education centers. The mobile centers can follow large groups of migrant families enroute between crop harvest areas and in locations where no fixed centers exist.

In addition to the elementary and secondary level instructional service, other satellite-delivered services will include:

-- Special adaptations of PBS and other early childhood programs.

-- Career education/guidance for both school-age migrants and their parents, to assist in relocating from migrant to permanent employment.

-- Language programs for the California and Texas-based streams and for the Puerto Rican portion of the east coast stream.

-- Computer-based School Records Transfer Program* so that a student's school achievement record is readily available no matter what part of the country he or she may happen to be in at a particular time.

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*A study by Perrine has indicated that there was little effort at joint curriculum development among states for migrants as of early 1975. However an interstate computerized migrant student record transfer program was in operation.

-- Continuing education program for teachers of migrants.

-- Personal health care program for migrants.

Channel Requirements

To serve the migrant population with the services outlined would require a dedicated full-time channel. In a multi-beam configuration, each of the three regions would, in effect, have its own channel. Although the traffic on such a channel would perhaps be light, with frequent slack periods, the requirement would be steady enough that it probably could not be met by a shared channel, since the migrant education sector might not be able to count on the availability of channel space when needed.

Delivery Points (Migrants)

Four video receive/transmit terminals would be required -- one for the national resource center and one for each of the regional centers. In addition, mobile and fixed location terminals would be required at points throughout each migrant stream. It is assumed here that a total of 30 terminals of the mobile variety would be required -- 10 for each stream. An average of 10 fixed location terminals per state would add up to a total of 470, since migrants move through 47 states [29]. Because it is believed migrant school children could benefit from the individually programmed instruction afforded by CAI, these terminals would need to have narrow band uplink capability.

2.8.2 Correctional Institutions

Roberts [30] has spelled out the following general objectives of correctional education:

1. To offer an inmate sufficient academic education to enable him to face the needs of the world as a better equipped person.
2. To provide vocational training so that he might take his proper place in society and be economically independent.
3. To offer cultural and hobby activities that will enable him not only to be better adjusted to his prison circumstances, but to broaden his area of interests and cultivate aptitudes looking forward to his return to civilian life.

According to this scenario, there will continue to be a need for an intensive effort to serve the nation's 420,000 incarcerated individuals* with educational services in all three categories suggested above. Roberts' 1971 report indicates that in the federal prison system, 15% of inmates were functionally illiterate, and 90% had not completed high school, despite average I.Q. scores of 104. It was estimated 80% possess no saleable skill. These statistics undoubtedly call for efforts in the first two categories, general education and vocational/technical education. The third general category, cultural and hobby activities (informal, leisure education) is especially appropriate for this population since the "typical" inmate spends only 7 hours in organized activity plus 10 hours eating and sleeping, leaving 7 hours of hard-to-fill free time [30]. These figures are for the federal prison system. The amount of organized activity in Federal prisons is probably considerably greater than in local and county jails.

This scenario envisions telecommunications services to inmates in all three educational categories. In the general education area, correctional institutions can be expected to tune into the adult basic education and G.E.D. preparation programs to be delivered by PBS, according to the previous Adult Education scenario. PBS will probably also be the main source for televised education in the cultural and hobby area. Although additional mediated services in this area may be provided through such devices as video cassettes, it is expected the PBS programs will provide the bulk of services delivered via large scale telecommunications. Since PBS has already been allocated channels in other scenarios, these services to the inmates of correctional institutions will not add to the total channel requirements.

---

*Approximately 21,000 in Federal prisons, the remainder in state and local institutions.

Use of large scale telecommunications to deliver vocational/technical training to prison inmates faces the same basic problems as it does outside prison walls. The market is fragmented. A 1972 report indicates federal prison inmates at 26 different institutions participated in at least 30 different categories of vocational/technical training. [31] However, correctional facilities may look to vocational/technical training networks organized by regional consortia of publicly-controlled vocational training centers, as suggested in the scenario on a career and vocational/technical education. Again, there would not be a requirement for added channel capacity, only for ground terminals at the correctional institutions.

Inmates will probably also utilize the Department of Labor job bank mentioned earlier. The computer-based job bank, along with personal counseling and computer-assisted career guidance would provide prisoners with a comprehensive package of career education services.

Inmates will probably also participate in university "external degree" programs, as well as secondary education programs coordinated by an organization such as the Agency for Instructional Television. For successful participation in these programs, inmates will receive credit from local school districts, community colleges, state boards of education etc., who will administer local testing and counseling. In the past, it has been found that such arrangements between prisons and local education authorities brings more favorable recognition from potential employers than if the correctional institution awarded certificates and diplomas in its own name. [30]

Inmates may not be the only individuals to participate in college preparatory courses, college courses or vocational programs. One source of friction between prisoners and guards in the federal prison system has been the fact that many educationally deprived guards have sometimes seen prisoners being offered better educational opportunities than the guards have; and access to educational services delivered via telecommunications could benefit guards as well as prisoners. [32]

The potential services outlined so far have all involved correctional system participation in services already envisioned for other segments of the population. Thus, extra channel capacity would not be required.

One additional area in which telecommunications might serve can be termed motivational and social education; that is, education designed to help the inmate acquire a desire and ability to get along with the "non-criminal" segment of society. Satellite interconnection would permit inmates of prisons throughout the country to engage in frequent rehabilitative teleseminars. Prison staff and officials could exchange information, ideas and experiences in the same manner.

Although it would be possible to have statewide and regional interconnections, this scenario anticipates a greater emphasis on nationwide interconnection of specialized institutions. For example, the federal prison system has youth and juvenile institutions in Kentucky, Colorado and West Virginia. [30]

It has been suggested here that most educational telecommunications for correctional institutions will involve inmate participation in educational services provided to the "outside" population and, therefore, extra channel requirements are limited. However, with the teleseminar activity discussed above and the additional possibility of some instructional television services designed specifically for the prison population, it is not difficult to envision a volume of traffic heavy enough to justify one dedicated channel.

Figure 7 shows how the correctional institution sector might be organized to take advantage of educational telecommunications services. As in other sectors, there is a public or private entity operating and coordinating the use of a satellite system. Major educational sectors distributing services via satellite make up the next tier in the framework. Since the bulk of telecommunications services utilized by correctional institutions is to be services provided by these major sectors rather than by the correctional system itself, a line of organization goes from the correctional system, represented by the American Correctional Association (A.C.A.) to each of the major sectors. Although a new organization to coordinate educational telecommunications activity for the correctional system could be established, the A.C.A., which is more a professional association than an operating agency, was named because it is the only organization inclusive of federal, state and local correctional systems.

Channel Requirements

Since most services are to come from other sectors previously allocated channel capacity, the additional channel requirement for the correctional system is minimal. One channel ought to be quite sufficient to accommodate traffic generated by interinstitutional teleseminars for inmates and staff as well as for a limited amount of instructional television developed exclusively for the prison population rather than for the "outside" population.

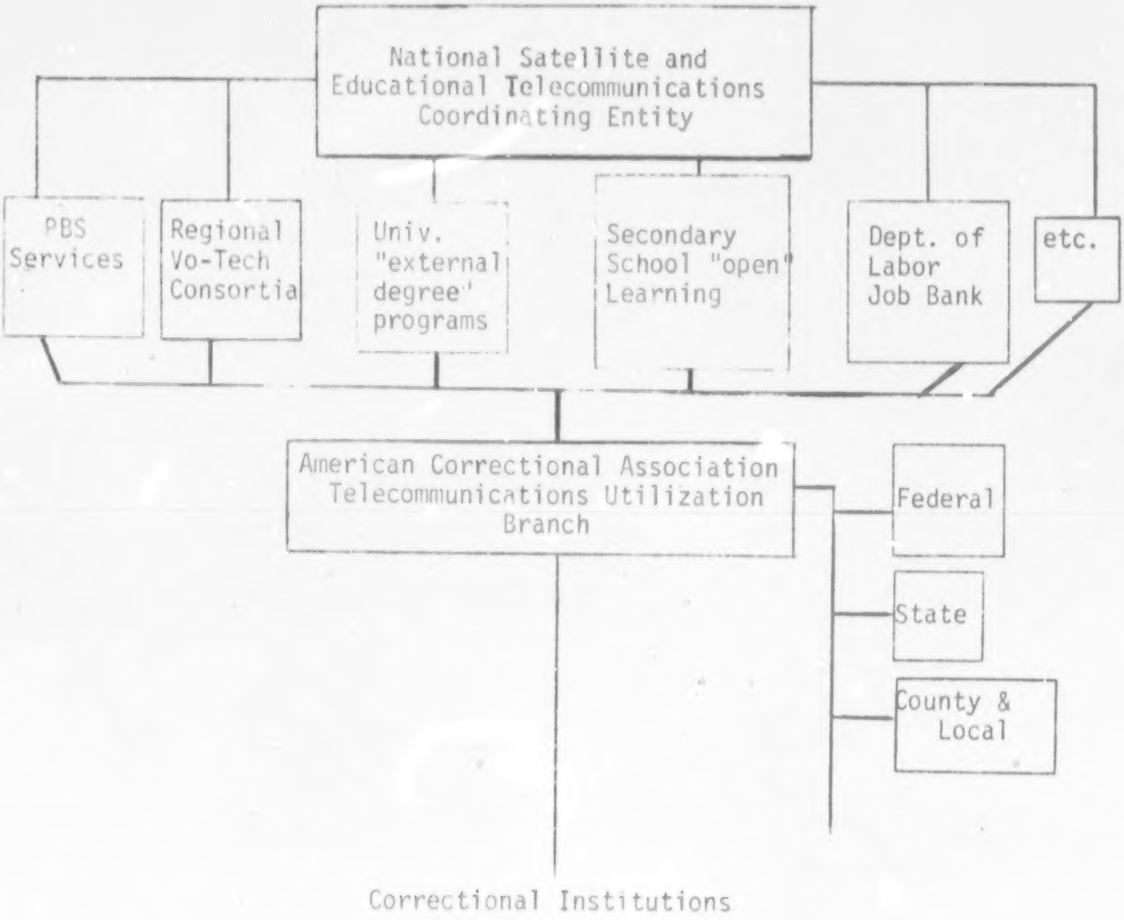
National Satellite and Educational Telecommunications Coordinating Entity
PBS Services
Regional Vo-Tech Consortia
Univ. "external degree" programs
Secondary School "open" Learning
Dept. of Labor Job Bank
etc.
American Correctional Association Telecommunications Utilization Branch
Federal
State
County & Local
Correctional Institutions

FIGURE 7

Organizational Framework for Delivery of Educational Telecommunications Service to Correctional Institutions

Delivery Points

Since interactive services are contemplated, delivery points would need to be equipped with terminals having at least narrowband return capability. According to 1972 statistics, 89.2% [33] of local jails are without any educational facilities, and stays are generally short-term; so it is probably unrealistic to think of most of the nation's 4,037 [33] jails as likely delivery points. For purposes of this analysis, it is assumed that each of the 26 federal prisons has a terminal and that each state has at least one institution equipped with a terminal. While some local and county institutions may become delivery points, it is assumed they are in communities equipped with cable or ITFS systems which can relay satellite signals to many users, including correctional institutions. The requirement, then, is for 26 + 50 = 76 terminals with narrowband uplink capability.

2.8.3 Handicapped (Special Education)

The school-age handicapped population which this scenario envisions being served by a large scale telecommunications system is fragmented into subgroups with different types of handicaps. Among them:

Impaired speech	*2.1 million
Mentally retarded	1.4 million
Emotionally disturbed	1.2 million
With learning disabilities	.6 million
Impaired hearing	.3 million
Orthopedically handicapped	.3 million
Impaired vision	.06 million
Multihandicapped	.04 million

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*The figures here are based on Reference [34] and have been rounded off.

The potential for using large scale telecommunications to aid in the education of handicapped children is greater for some subgroups than for others; and the telecommunications service that would be useful also differs by handicap category. The very nature of special education requires and will continue to require that the instructional "mix" in education for the handicapped be teacher intensive rather than technology intensive. On the other hand, this scenario anticipates that telecommunications will be useful both in doing some things better than teachers can and in delivering educational services to those handicapped children who can't be reached by currently available means, i.e., homebound and hospitalized children.

Approximately 34 thousand children fall into the homebound or hospitalized category, so that although providing educational services to them may deserve a high social priority, the market is quite small considering economies of scale in satellite communications. [3] It seems likely that services for this audience will be delivered at the local level, either by teacher visitation or local electronic distribution, such as cable. However, where the confined students' needs overlap either with school-based students and non-handicapped children who learn at home by choice, the potential for telecommunications is greater.

This scenario anticipates that large scale telecommunications in education of handicapped children will best serve 2.6 million mentally retarded and emotionally disturbed children, .3 million children with impaired hearing and 60 thousand visually impaired students.

Students in the mentally retarded and emotionally disturbed categories may benefit most from computer-assisted instruction (CAI). Rothenberg [3] has speculated that programmed instruction, of which CAI may be an electronic version, can enable instructors of the retarded and emotionally disturbed to define learning objectives in behavioral terms and to construct lessons into discrete units.

For those students with severely or completely impaired hearing, the currently most promising technology is electronically captioned television programs, so the deaf can receive the verbal as well as visual portion of a program. It is expected that by the time an educational satellite system is ready to fly, the captioned television technique will have been perfected and software production methods refined so that deaf children may benefit from the satellite system's video services.*

A potential service for the visually impaired involves use of electronic magnification techniques, now in early development, to display enlarged editions of printed materials on a TV screen. It is anticipated by this scenario that such a service will tie in with automated remote retrieval of audio and magnified visual library resources in an educational telecommunications network.

The applications described so far involve direct instructional techniques, aimed at the student rather than the teacher. Another important potential for telecommunications assistance to the handicapped is in distribution of educational materials among schools for use by teachers. In connection with this, this scenario anticipates development of a materials distribution network that would involve the addition of electronic interconnection to an already existing system of Special Educational Materials Centers and Regional Media Centers for the Deaf (funded by the federal government) and currently 200 existing Associate Centers (founded by state and local sources). This network already is extensively involved in distribution of materials by conventional (i.e., the mail) means and electronic interconnection is currently being envisaged by the officials of the network.

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*As of early 1975 captioned TV could be found on both commercial and public television news broadcasts.

It is expected that this network will be the focal point of an educational telecommunications service for the handicapped. Organizationally, it will dovetail nicely with already functioning cooperation among school districts in providing services for the handicapped. Figure 8 illustrates the structure envisioned in this scenario.

Channel Requirements

With no basis for estimating the volume of traffic which might be generated in the special education subsector, it is difficult to come up with a satellite channel requirement. Although the network for distribution of educational materials for the handicapped consists of many repositories, our "feel" for the market would seem to indicate a relatively light volume of traffic per center. The direct instructional services outlined -- television captions, magnification of library materials, CAI*, and audio distribution will not occupy the channel space that would be taken up by regular television distribution.

One full-time satellite channel, with extra traffic being scheduled on shared channels would seem to be a realistic estimate.

Delivery Points

Because of the large number of materials distribution centers, the cost for ground terminals will be high. Video receive/transmit terminals would be required at each of 4 Regional Media Centers for the Deaf and 18 Instructional Media Centers. The 200 associate centers

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*CAI requirements should be reassessed in light of the forthcoming Morley and Eastwood study being completed at our Center.

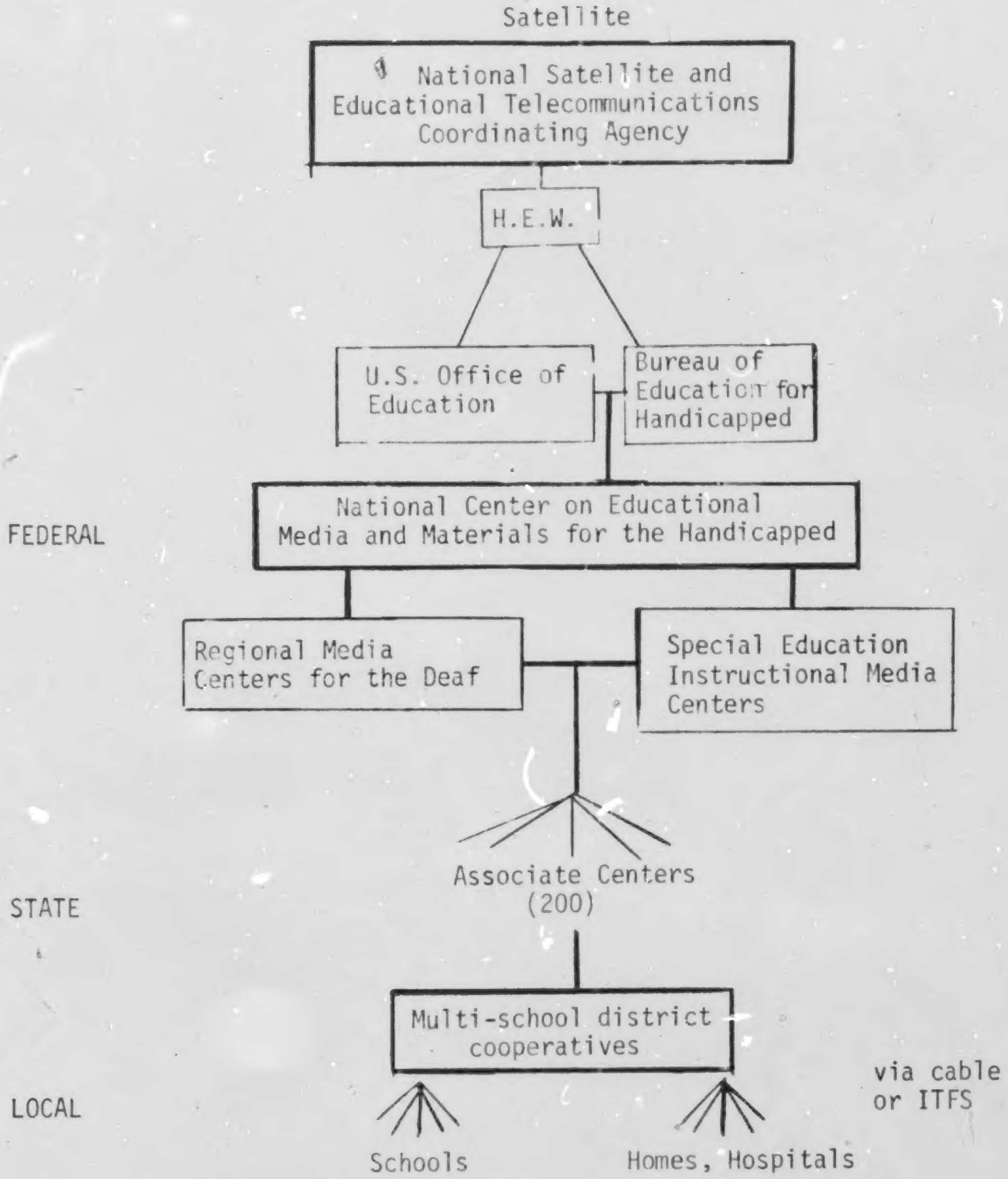
Satellite
National Satellite and Educational Telecommunications Coordinating Agency
H.E.W.
U.S. Office of Education
Bureau of Education for Handicapped
FEDERAL
National Center on Educational Media and Materials for the Handicapped
Regional Media Centers for the Deaf
Special Education Instructional Media Centers
STATE
Associate Centers (200)
Multi-school district cooperatives
LOCAL
via cable or ITFS
Schools
Homes, Hospitals

FIGURE 8

Organizational Frameworks for Delivery of Educational Telecommunications Services to the Handicapped would not distribute video via satellite but might well serve as hubs for teleconference networks, interconnecting special education teachers. Therefore, narrowband uplink capability would be required.

Most schools would receive signals either by cable or through ground terminals already constructed for accommodating services other than special education. Homes and hospitals would also be served through local distribution channels.

In summary, channel and delivery point requirements for serving the handicapped are:

Channels

1 Full-time channel
  - other channels required on occasional, scheduled access basis.

Delivery Points

22 Receive/transmit terminals

200 Limited 2-way terminals

2.9 COMPUTER AND INFORMATION SERVICES

This section is concerned with the use of telecommunications to interconnect computer resources, libraries and special information systems. Computer/information networks do not constitute a separate educational sector, but they do represent a potentially important segment of the market for an educational telecommunications system, from which each of the sectors discussed in previous scenarios stands to benefit.

The importance of this segment of the educational telecommunications market rests not so much with the quantity of satellite channel requirements it might generate as it does with the nature of the services themselves and with their significance to remote areas currently without access to computer and information resources. In addition to making these resources available to lightly populated remote areas, telecommunications will be used to combine the specialized computer-information resources currently scattered throughout the country into a single nationwide pool of resources which can be accessed from any location. It should be noted that the economic and socio-political feasibility of this is uncertain and requires analysis.

The educational telecommunications services envisioned within this segment of the market are perhaps among the more exotic and imaginative which educational technologists have envisioned. They are less familiar to potential users than television is, and they are highly interactive services.

Although there are computer and library applications which are unrelated to one another, the line between computers and information processing technology has become increasingly blurred in recent years and will continue to do so. For this reason, these fields are treated here as a single market.

There are three basic submarkets within the computer/information services field:

1. Interlibrary Cooperation and Distribution of Library Materials -- This submarket involves the interconnection of libraries to pool loan materials (i.e., interlibrary loans) and to cooperate in processing bibliographic and cataloging information. The former is cooperation in the area of consumer services, while the latter is cooperation in internal administration. Also included are such possibilities as distribution of library materials to consumers via television, computer terminal display or other electronic means.
2. Information networks -- This submarket includes what might be termed "electronic reference shelf" services. In general, it would be segmented

into specialized areas, examples would include bibliographic search services, such as the National Library of Medicine's MEDLINE: an electronic equivalent of the World Almanac; government "hotlines" providing information about government services and records held by public agencies, computer-stored statistical data, such as Census Bureau tapes, etc. To protect privacy, freely accessible statistical data and other records would need to be confined to the aggregate level -- i.e., excluding data on individuals.

3. Computer Services -- Services related to interlibrary cooperation and information networks will be "computer-controlled." The "computer services" submarket, however, concerns those services in which computer resources play a role that is more central than just serving as a control mechanism for distribution of library or information resources. Included are sharing of raw computing power, instructional applications (CAI and computer managed instruction, computer games); research applications (remote batch processing, interactive data processing, computer simulations); and administrative applications (remote batch processing and interactive data processing for records management and planning purposes).

Scenarios for the development of these submarkets will now be described.

2.9.1 Interlibrary Cooperation and Distribution of Loan Materials

1. Nationwide access to Library of Congress Materials. The Library of Congress will be at the top of a hierarchical system, accessible only after lower-level centers have been searched. The Library of Congress will be augmented by 10 designated regional centers located at major academic libraries, which will serve as the next highest level in the hierarchy. The regional centers will be accessed only after state public library systems or regional interuniversity library networks have been searched.

Depending on urgency, requested materials will be distributed off-line, via teletype or facsimile. Interactive terminals would be required at 11 points (the Library of Congress and 10 hypothetical regional centers). Because of the heavy traffic load on these centers, alphanumeric display CRT terminals will be utilized to facilitate speed in communications among the Library of Congress and the 10 centers.

2. Each state will have a state library and a statewide public library system. Most states already have state libraries and many statewide systems. Because most materials can be distributed off-line in a reasonable amount of time, most traffic generated by the state library systems will be teletype searches and requests.

   The estimated number of public libraries in this system is 12,000. However, due to the possibility of utilizing cable channels, the estimated need for interactive ground terminals colocated with libraries is 2500.

3. There will be at least 12 major regional intercollegiate library networks serving approximately 2500 universities, colleges and community colleges. This may be an underestimate, in view of the already existing number of regional computing networks [38] and inter-library arrangements [41].

4. Perhaps six major research libraries, such as the University of Chicago's Center for Research Libraries, housing rarely used research materials, will service the 12 regional intercollegiate networks. Communications will be via teletype and circulation will be off-line.

5. A dozen major corporate libraries will interconnect with their branch offices and among themselves. Communications will be via teletype, with circulation off-line, except for urgent, small requests which can be distributed via facsimile. Schools might be able to benefit from access to these special corporate collections.
6. About five major networks will exist for the purposes of cooperation in the production of catalog information and cards. One major network providing such a service to a large number of subscribers throughout the country is the Ohio College Library Center (OCLC), which uses CRT terminals [39]. Subscribers will already have ground terminals for participation in other interlibrary networks.
7. In addition to ground terminals and teletypes at libraries, non-library locations such as secondary schools and community learning centers will be equipped with teletypes of CRTs. Since they will have ground terminals for other educational telecommunication services, no additional terminals would be required.

The sum requirements for ground terminals for the library segment of the computer information market amount to roughly 3000 with narrow-band return capability.

There is a little information upon which to base the channel requirements for the services outlined above. However almost all satellite communication among libraries would be of the narrowband sort, primarily using teletype and, to a limited extent, facsimile, which consume relatively small amounts of channel space. Using 500 as the number of voice circuits on a single satellite channel and 640 as the number of teletypewriters which can transmit on a voice circuit at one time, it can be estimated that 320,000 teletypes could transmit simultaneously on one satellite channel. In a four beam configuration 1.28 million teletypes could transmit simultaneously. Assuming that a peak load for teletype communication in the computer/information services market would be much less, interlibrary communications would make only a small dent in the total information carrying capacity of a satellite channel.

Although high resolution (television-quality) video display of library materials will occur, this scenario anticipates that long distance transmission via satellite of such displays would be too costly and cannot realistically be forecast. More likely is facsimile transmission.

2.9.2 Information Networks

There are a large number of potential "reference shelf" type services. Only a few are itemized here. A review of the services seems to indicate that most involve delivery points already having ground terminals because of participation in library services or other services provided to other major educational sectors. So the additional load imposed by these services would most likely be satellite traffic rather than a need for more terminals. Some exceptions will be noted.

1. MEDLINE - the National Library of Medicine's on-line bibliographic search system will be expanded to provide a capability for on-line retrieval of medical facts for researchers, practicing physicians and people in related fields.
2. BRIEF - this will be a new on-line service for attorneys, legal

researchers, and law students. Sponsored by the Association of American Law Schools, this service will aid students and attorneys in the preparation of case briefs and will assist legal researchers in searching archives of law documents. It should be noted that BRIEF, like a number of other services discussed in this collection of scenarios, is not actually planned, to our knowledge, but does strike the authors as a realistic and useful possibility. Perhaps up to 250 law schools and bar association libraries would have ground terminals.

3. National Agricultural Library - One of the currently existing national libraries, NAL could be expanded into an on-line bibliographic search and information retrieval service in fields related to the agricultural sciences. Delivery points could include universities as well as state extension service offices.
4. ERIC -- An on-line version of the Educational Research Information Clearinghouse Network would be a logical extension of current service.
5. FEDBIB - An on-line system for sharing bibliographic information among government agencies and offices was in the planning/experiment stage as of 1973 [40]. As an expansion of this, on-line public access to information available from federal agencies would be developed. Perhaps 50-100 interactive ground terminals located at government sites would be required.
6. State equivalents of FEDBIB - some states already provide such services via telephone. An additional 50 interactive ground terminals would be needed.
7. New York Times Data Bank - Initially developed for use by New York Times staffers, this on-line information service is now

marketed as a commercial enterprise [41].

It is hard to estimate how much traffic would be generated by the above services. For purposes of this scenario, we assume the same number of terminals in use at a given time as were estimated for interlibrary services -- 15-20 thousand. However, we also contemplate the use of mostly CRT terminals rather than teletypes, as forecast for such library services as MEDLINE. CRTs involve a much higher data rate [42]. Assuming a voice circuit can handle 25 CRTs (alphanumeric display) simultaneously, compared to 640 teletypes, it would be reasonable to estimate that "information Network" services would make full use of an entire satellite channel. Approximately 400 additional interactive ground terminals would be required.

2.9.3 Computer Services

In addition to the computer-controlled services discussed above, this scenario anticipates computer utilization for research, administration and instruction to increase by many times by the year 1990.

A network of national scope, with access governed on a hierarchical basis, is expected. A major exception to this will be the Defense Department's Advanced Research Projects Agency (ARPA) Network -- an interconnected system of 20 autonomous computer systems, which is a distributed resource configuration, since each mode in the system houses specialized facilities that add to the combined resources of the entire system.

With few exceptions such as ARPA, it is anticipated that a computer need will be satisfied locally if possible, or at the lowest level in the hierarchy of local, district, state, regional and national systems where the need can be met.

At this point in time, many computer time sharing systems involve large university owned computer systems with excess capacity. A prime motivation in permitting non-university users to have access to the computer has been the desire to make profitable use of idle computer time [38]. It has been pointed out that this may not be the ideal arrangement in the long-run, for two reasons. First, as computer usage expands, universities may not have enough time available to meet outside requirements. Second, non-university users have no way of insuring that the system will be optimized to serve their special needs.

Based on those considerations, this scenario envisions a fading out of university-time sharing systems and a fading in of regional computer systems controlled by consortia of coequal users. There will also be an expansion of commercially and publicly owned computer utilities.

It has been noted by Singh and Morgan [42] that forecasters' most optimistic estimates have not been able to keep pace with actual growth of computing in the United States. Although this scenario is "bullish" on large scale utilities, it is difficult to forecast to what extent the development of mini-computers will alter this picture.

Because of continually dropping prices in computer hardware, it is expected that much of the growth in computer utilization will occur in the use of locally owned computer systems. The use of satellites in computer communications will be for long distance interconnection of district, regional and national computer facilities. These should have three basic applications:

1. Delivery of computer resources to small, remote areas which cannot afford their own facilities. Development here depends on the inroads made by minicomputers.
2. Computer projects that require the capabilities of "super-computers."

3. Computer projects requiring software that is so expensive or rarely used, that only one or a few centers can store it.

Figure 9 shows the large number of educational applications of computers that are likely to develop in different educational sectors. There is no firm basis upon which to translate those applications into satellite channel requirements. Perhaps a more reasonable way of looking at the situation would be to examine how much traffic a satellite channel can handle at any given time.

The transmission rate in computer communications will vary with the type of application being considered. Computer-to-computer applications involve a much higher rate than applications such as CAI, where speed is confined at one end by human limitations. If we assume a relatively high rate of 10 kilobits per second for an average, then a 64 kb/second voice channel could accommodate 6.4 simultaneous users. Assuming 500 voice circuits per satellite channel, a single satellite channel could accommodate 3200 users. If a single channel illuminates four separate beam areas, then one channel could actually accommodate 12,800 simultaneous users.

Given that only a small fraction of members of the educational sector will use computers in any particular moment and that only a small fraction of those using computers in a particular moment will be using long distance satellite circuits, a capacity of 12,800 simultaneous users showed suffice. In some rural areas, and large isolated areas such as Alaska, dependence on distant computers and satellite channels per user may be greater; but the number of users will be smaller.

We therefore "guesstimate" that no more than the capacity of two satellite channels in a switched-beam configuration would be required to accommodate computer services.

	Instructional Applications of Computers					Administrative Applications of Computers				Research Applications of Computers								Library Applications		
	Instruction about Computers			Instruction with Computers						Research on Computers			Research with Computers							
	Specialist Instruction	Service Instruction	Survey Instruction	Computer Assisted Instruction/ Computer Based Instruction/ Computer Managed Instruction	Computer Assisted Problem Solving	Computerized Financial Operations	Computerized Personnel Management	Computerized Program Management	Computerized Facility Management	Hardware Oriented Research	Software Oriented Research	Research on Theory and Science of Computing	Number Processing	Symbol Processing	Data Processing	Event Processing	Picture and Sound Processing	Circulation Automation and Computer Aided Cataloguing	Computerized Indexing and Retrieval	Computer Aided Vocational Guidance
Elementary Schools				X		X	X	X	X						X					
Secondary Schools			X	X	X	X	X	X	X						X					X
School District						X	X	X	X						X			X		
Vocational Schools	X		X	X		X	X	X	X						X					
Community Colleges	X	X	X	X	X	X	X	X	X						X					X
Colleges	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X	
Universities	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

Figure 9. Computer Applications in Education
(from reference 42)

Although a few additional interactive ground terminals might be required to serve computer users, it is assumed that district and regional "super-computers" would be located at resource centers already accounted for in previous sectors and that computer users would be located at points also accounted for in previous scenarios.

2.9.4 Organizational Structures

Previous scenarios dealt with individual educational sectors, and the institutional and organizational aspects of the respective delivery system were relatively uncomplicated when compared with the situation for the computer and information services market, which cuts across the lines of several different educational sectors. What will be needed is a framework for bringing all the various services into a coordinated effort, so that one educational sector can share the computer and information resources of another sector.

Of necessity, the organizational structure and physical configuration of computer/information networking will vary with the type of service being delivered and the educational sector being served. For example, most of the "information network" services alluded to involve centralized applications of telecommunications; i.e., information is stored and distributed to users from one point and, perhaps, from a few branch distribution points. Library services, on the other hand, involve both decentralized services with distributed resources (e.g., interlibrary loan) and centralized services (e.g., library-to-consumer distribution and catalog card production).

There are a variety of instructional arrangements too, ranging from intercollege cooperation to services which are sponsored by public library systems, government agencies and commercial organizations. This scenario envisions a pattern of evolution of telecommunications usage that is segmented and continued within, rather than among, the various institutional groups. The segmented evolution is "Phase I" of computer/information network development. "Phase II" is envisioned as a coalescing of the various segments. In other words, the members of public library networks will be able to call upon the resources of collegiate networks. Both will be able to call upon the specialized reference services, such as MEDLINE.

Development of cooperation in the computer area should be somewhat more orderly than in the library area. Although computer centers and networks are also controlled by various types of institutions and organizations, with both centralized and distributed resource configurations, one common thread is the basic commodity -- computer power. The situation in library and information networking involves several very different commodities, ranging from catalog card production to "reference shelf" services to interlibrary loans.

Because of the factors outlined above, the type of organization and cooperation required to promote systematic development is not a "chain-of-command" type of framework. There will be a number of chains-of-command, different for each segment of the markets. What is required, instead, is an organization that will provide a focal point for voluntary cooperation in five key areas.

1. Standardization -- If the coalescing of segments forecast earlier is to take place, systems that wish to be in on the act must agree to standards which will bring about compability among components and systems. An example of such

cooperation has been development of standard software language for the exchange of catalog card information; i.e., the Library of Congress MARC (Machine Readable Cataloging) format [36].

2. Uniformity of Channels -- If all the various segments of a comprehensive computer-information system are going to be able to use satellites to communicate with each other, they should all utilize the same channels. Since a large scale satellite service for education may involve a large number of channels, one or a small portion of those channels should be selected as the route for computer/information system traffic.

3. Protocal -- To provide for an orderly flow of communication traffic, participants in a computer/information system will need to agree on "rules of the game." Emery [37] has suggested a hierarchical structure for computer networks. Local needs would search local resources before going to an intermediate level or beyond. This would seem to make sense for library and information networking too.

   The "hierarchy" would have both a vertical and a horizontal dimension; that is, needs would be met at the local level if possible. If not, an intermediate level would be queried before going to the national level. By "horizontal" dimension, we mean that a public library network, for example, would search its own resources before moving over to a collegiate library network.

4. Financial arrangements -- A schedule of prices will need to be devised to provide compensation to a segment which serves another

segment. Although actual transactions might be between the two segments rather than through the coordinating organization, a central organization will need to compile and distribute price information.

5. Channeling funds -- A coordinating body could be the conduit for federal funds which might be appropriated in the future. It is assumed that the federal government will eventually provide funds to encourage cooperative efforts in providing computer/information services. The government has already used National Science Foundation funds to support development of 25 regional computing networks from 1968-72. [38] A 1968 amendment to the Higher Education Act of 1965, "Networks for Knowledge," was designed to encourage cooperative efforts among university libraries. However, funds were never appropriated to implement "Networks for Knowledge." [36]

The coordinating body, which could be an existing organization like EDUCOM or a new entity, which we will call the National Council for Information Networking, would be governed by representatives from the various educational sectors that would participate in a computer/information system of national scope. It is expected that the organizations representing these segments would be more highly structured than the national council, with more formal lines of authority.

2.9.5 Total Channel and Ground Terminal Requirements

In discussing library services, information networks and computer services, the above analysis arrives at a total requirement of 3-4 satellite channels (a fraction of the capacity of a single channel for library services, 1 channel for information networks and 2 channels for computer services.)

Also, in addition to shared ground terminals, 3400 interactive terminals would be required.

2.10 SUMMARY OF CHANNEL AND GROUND TERMINAL REQUIREMENTS

This section extracts satellite transponder* and ground terminal placement requirements from the preceding scenarios. It must again be emphasized that these "requirements" are, at best, educated guesses based on a great many assumptions about the future of education and telecommunications. The channel and ground terminal requirements estimates can be no better than those assumptions.

2.10.1 Public Broadcasting

Channel Requirements: In the short term, for conversion of existing services from terrestrial to satellite interconnection, the Public Broadcasting Service estimates a requirement for 2-4 full-time video channels (1 for each time zone or 1 for two zones) for delivery of the basic national programming service, which includes extra channels for a West Coast time delay. 1 additional channel is required on a scheduled access basis 31-58 hours/week for regional programming, special time delay and program assembly. 1 more channel is required on an unpredictable need basis 7 hours/week.

Assuming a switched beam satellite system, the number of transponder hours required for regional programming could be reduced, since one transponder could be used in multiple regions.

Ground Terminal Requirements: Short-term ground terminal requirements are for 99 receive-only terminals located at PBS network stations and 28 receive/transmit terminals located at stations designated PBS origination points.

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*The transponder referred to here is capable of handling one video carrier or equivalent voice/data lines.

Channel Requirements, long term: In the long term, according to the scenario, public broadcasting will require an addition 4 full time channels (2 for 2nd channel via cable, 2 for instructional and increased regional programming); 10 additional channel hours/week on a scheduled access basis for increased program assembly; and 7 more channel hours per week on an unpredictable need basis.

Adding on long term channel requirements brings the total to 6-8 full-time channels; 1-3 channels on a scheduled access basis 41-68 hours/week; and 1 channel on an unpredictable need basis 14 hours/week.

Ground Terminal Requirements, long-term: No additional requirement.

Transponder Requirements

Full-Time	Scheduled Access	Unpredictable Need
Short term 2-4	1-3 (31-58 hrs/wk)	1 (7 hrs/week)
Long term 6-8	1-3 (41-68 hrs/wk)	1 (14 hrs/wk)

Ground Terminal Requirements*

Receive/Transmit	Ltd. 2-way	Receive/only
28	0	99

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*These requirements pre-date new PBS planning initiatives for interconnection of 150 public broadcasting stations via satellite.

2.10.2 Early Childhood Education

Channel Requirements: Since Public Broadcasting in our scenario is to be the primary delivery vehicle for telecommunications services for early childhood education, channel requirements other than those allocated public broadcast are minimal. However, some requirements for channel capacity will be generated by services for early childhood education specialists, who will be served partly by a national early childhood education consortium and regional organizations not connected to public broadcasting. Some of the channel requirements generating services would be computer-based educational management, an on-line ERIC service, CAI for early childhood specialists etc. One satellite channel on a scheduled access basis during weekdays, daytime hours (8 a.m. - to 5 p.m.) would suffice.

Ground Terminal Requirements: Delivery points will be reached either by over-the-air television or via satellite ground terminals shared with other sectors, such as those located at cable headends or community centers. 1 receive/terminal is required for the early childhood education consortium resource center.

Transponder Requirements

Full-time	Scheduled Access	Unpredictable Need
0	1 (45 hrs/wk)	0

Ground Terminal Requirements

Receive/Transmit	Ltd. 2-way	Receive-Only
1	0	0

2.10.3 Elementary and Secondary Education

Channel Requirements: According to the scenario, PBS will not be the primary delivery vehicle for services for elementary and secondary education. Two full-time transponders will be required mostly for school-oriented television distribution, and one additional full-time transponder will be required for computer-based services. Three transponders will be required on a scheduled access basis for nationally distributed "open education" 50 hrs/wk 8-6 pm. Monday-Friday.

Ground Terminals: 15 - to 20 thousand limited 2-way (community) Receivers or dedicated channels on shared terminals would be required in rural locations and a portion of urban areas not served by cable. There is a possibility that interactive terminals could be confined to only the 2500 most remote locations and receive only terminals located at the remaining 12,500-17,500 locations. One receive/transmit terminal would be required for the Agency for Instructional Television's elementary and secondary education center.

Channel Requirements

Full-time	Scheduled Access	Unpredictable Need
3	3 (50 hrs/wk each) M-F 8-6 p.m.	0

Ground Terminal Requirements

	Receive/Transmit	Ltd. 2-way	Receive/Only
Case 1	1	15,000-20,000	0
Case 2	1	2,500	12,500-17,500

2.10.4 Career and Vocational Technical Education

Except for some PBS programming in the career education area, the role of satellite-delivered television will be minimal. Satellite circuits will be used in connection with a on-line Department of Labor Job Bank system, career guidance CAI packages and, occasionally, CAI in the vocational-technical education area. Traffic imposed by this sector is expected to be so thin compared with other sectors that no full-time satellite transponders or dedicated ground terminals will be required. Regular but light use of satellite-capacity will be made on a scheduled access basis.

2.10.5 Adult Education

Channel Requirements: Adult education, and its subsectors - adult basic, continuing career education, continuing professional education, continuing informal education, and continuing formal education - will be heavy users of large scale telecommunications services. However, most of these services will be delivered via satellite channels allocated to the public broadcasting and higher education sectors. Some independent use of satellite channels will be made in the areas of continuing career education and continuing education for professionals, but the channel requirements for these areas can be met through occasional scheduled use of non-dedicated transponders.

Ground Terminal Requirements: One transmit/receive terminal will be required for a National Instructional Resource Center for Continuing Teacher Education. 150 limited two-way terminals will be needed at corporate locations for continuing career/professional education, and 2500 limited 2-way terminals will be needed at hospitals and medical centers who cannot gain access to services through cable systems.

Transponder Requirements

Full-time	Scheduled Access	Unpredictable
0	Occasional	0

Ground Terminal Requirements

Receive/Transmit	Limited 2-way	Receive-Only
1	2650	0

2.10.6 Higher Education

Channel Requirements: Four full-time transponders or video circuits will be required for delivery of campus-oriented services, assuming a switched beam configuration that will in effect turn 4 channels into 16 on a time-shared basis. An additional full-time channel will be required for a health sciences education network, and two channels will be needed full-time for external degree programs, again assuming a switched beam system.

Ground Terminal Requirements: Ten receive/transmit terminals will be needed, one for each ten external degree origination centers. One receive/transmit terminal will be required in each of seven Health Sciences Education origination centers, and one receive/transmit terminal will be needed for the Agency for Instructional Television higher education resource center. So a total of 18 receive transmit terminals will be required.

Limited 2-way terminals will be required at 15-20 thousand locations in rural areas and urban areas without cable and at 500-750 campuses without cable, for a total of 15,500-20,750.

Video Circuit or Equivalent Requirements

Full-Time	Scheduled Access	Unpredictable Need
7	0	0

Ground Terminal Requirements

Receive/Transmit	Limited 2-way	Receive Only
18	15,500 - 20,750	0

2.10.7 Special Educational Markets: Migrants, Handicapped, Correctional Institutions

Channel Requirements: One full-time satellite transponder will be required for each of the three submarkets we have considered in the Special Educational Markets category.

Ground Terminal Requirements: 26 receive/transmit terminals will be needed, one at each of 3 regional origination centers for migrant education, 1 at a national migrant education center, and 22 at each of the media centers of the instructional materials distribution network for the handicapped. 500 limited 2-way terminals will be required for migrant education centers, 76 for correctional institutions and 200 at associate centers in the network for the handicapped -- a total of 776 limited 2-way terminals.

Transponder Requirements

Full-time	Scheduled Access	Unpredictable Need
3	0	0

Ground Terminal Requirements

Receive/Transmit	Limited 2-way	Receive-Only
26	776	0

2.10.8 Computer and Information Services

Channel Requirements: No more than 3 or 4 transponders should be required in this sector, assuming a switched beam system. 1 would be needed for information networks, 2 for computer services because of the higher transmission rate of the CRT terminals to be used, and a fraction of a full channel's capacity for library services (where low speed teletypewriters will be the primary mode of communications.)

Ground Terminal Requirements: Although most terminals in this sector will be shared terminals, many utilizing cable, about 3400 limited two-way terminals will be required at public libraries, government offices and campuses not hooked into shared terminals.

Transponder Requirements

Full-Time	Scheduled Access	Unpredictable Need
3-4	0	0

Ground Terminal Requirements

Receive/Transmit	Limited 2-way	Receive-Only
0	3400	0

Other Ground Terminal Requirements: 15-20 thousand non-dedicated limited two way terminals will be needed at cable headends and community learning centers. 10 receive/transmit terminals will be required for each Regional Educational Resource Center that will be serving all educational sectors.

Table 5 and 6 summarize transponder and ground terminal requirements for our hypothetical large-scale educational satellite system. It will be noted, perhaps with some surprise, that relatively few receive-only terminals are called for. This is because we have contemplated the most advanced requirements for the various educational sectors; and they happen to involve many interactive services for which receive-only terminals would be of little use. If we contemplated an educational television system instead, more receive-only and fewer limited 2-way* terminals would be required.

When one considers the scenarios which have been set forth in the preceding pages, it becomes evident that it is possible to develop a plausible case for a hypothetical requirement for a rather large capacity and, we hasten to add, expensive, satellite system to serve education. Tables 5 and 6 summarizing transponder and ground terminal requirements attest to that. This report does not attempt to "cost" such a system.

2.11 SUMMARY OF POSSIBLE ORGANIZATIONAL FRAMEWORKS: THE EDUCATIONAL SUBSECTORS; RELATION TO OVERALL SYSTEM

In the preceding pages, each educational subsector was considered separately. Educational telecommunications organizational frameworks were

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*Earth terminals with wideband receive and narrowband voice/data transmit capability.

SUMMARY OF TRANSPONDER REQUIREMENTS FOR A HYPOTHETICAL LARGE-SCALE EDUCATIONAL SATELLITE SYSTEM

	Full-time	Scheduled Access	Unpredictable Need
Public Broadcasting (long-term)	6-8	1-3	1
Early Childhood Education	0	1	0
Elementary and Secondary	3	3	0
Career/Vocational	0	minimal	0
Adult Education	0	occasional	0
Higher Education	7	0	0
Special Markets:			
Migrants	1		-
Prisons	1	-	-
Handicapped	1	—	-
Computer/Information Services	3-4		
TOTAL	22-25	5-7	1

Table 5

SUMMARY - GROUND TERMINAL REQUIREMENTS FOR A HYPOTHETICAL LARGE-SCALE EDUCATIONAL SATELLITE SYSTEM

	Receive/Transmit	Limited 2-way**	Receive-only
Public Broadcasting	28	0	99
Early Childhood Education	1	0	0
Elementary and Secondary	1	15-20,000***	0
Career/Vocational	0	0	0
Adult Education	1	2650	0
Higher Education	18	15,500-20,750	0
Special Markets:			
Migrants	4	500*	0
Prisons	0	76	0
Handicapped	22	200	0
Computer/Information Services	0	3400	0
Regional Resource Centers	10	---	-
Cable headends and Learning Centers	-	15,000-20,000	-
TOTAL	85	52,300-67,600 (rounded off)	99

Table 6

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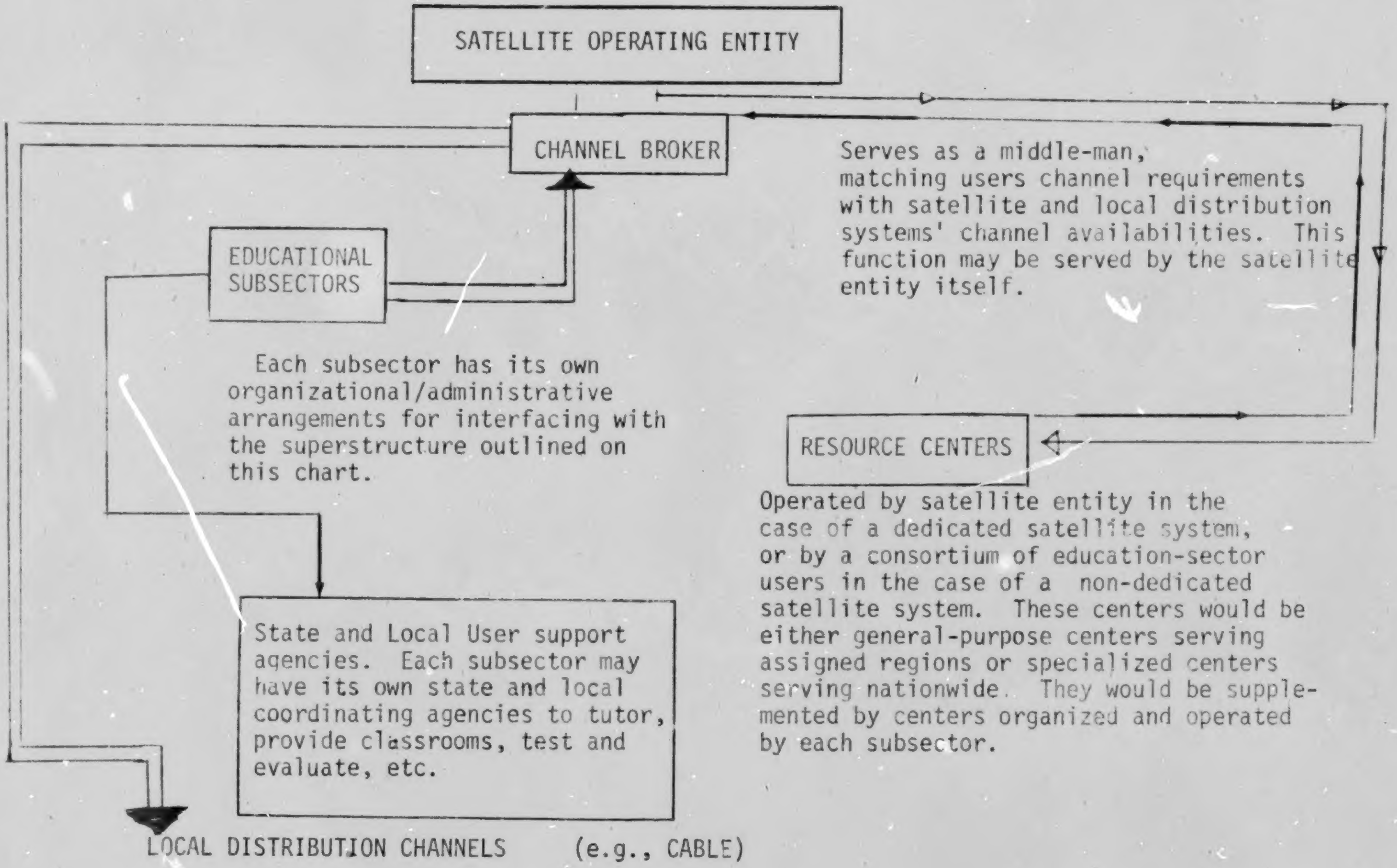
* includes 30 mobile terminals.

** Earth terminals with wideband receive and narrowband voice/data transmit capability.

*** If the requirement for limited 2-way terminals were confined to the 2500 most remote locations, the total figure could be reduced by as much as 17,500.

outlined for several of these subsectors. At the top of each organizational chart was a "box" labeled "National Satellite and Educational Telecommunications Coordinating Entity." This national entity is a single superstructure common to all the subsectors discussed in the previous pages. Four possible organizational framework alternatives for this superstructure are the subject of the following section. Basically, the superstructure is comprised of the satellite system and associated ground terminals, some kind of interface between users and the satellite operator to match up satellite and cable channel requirements with channel availabilities (i.e., a channel broker function), resource centers for storage of materials to be distributed via satellite, and local user support activities (such as tutoring, certification, etc.) Figure 10 depicts the organizational superstructure with which each educational subsector must interface.

Every bit as important as the organizational framework for control of the satellite component of an educational telecommunications system are the organizational and institutional arrangements within the educational community itself which are needed to exploit the satellite system. Figure 11 summairzes for various educational subsectors some possible organizational and service elements of each based on the previous scenarios.


SATELLITE OPERATING ENTITY
CHANNEL BROKER
EDUCATIONAL SUBSECTORS
RESOURCE CENTERS
LOCAL DISTRIBUTION CHANNELS (e.g., CABLE)

Serves as a middle-man, matching users channel requirements with satellite and local distribution systems' channel availabilities. This function may be served by the satellite entity itself.

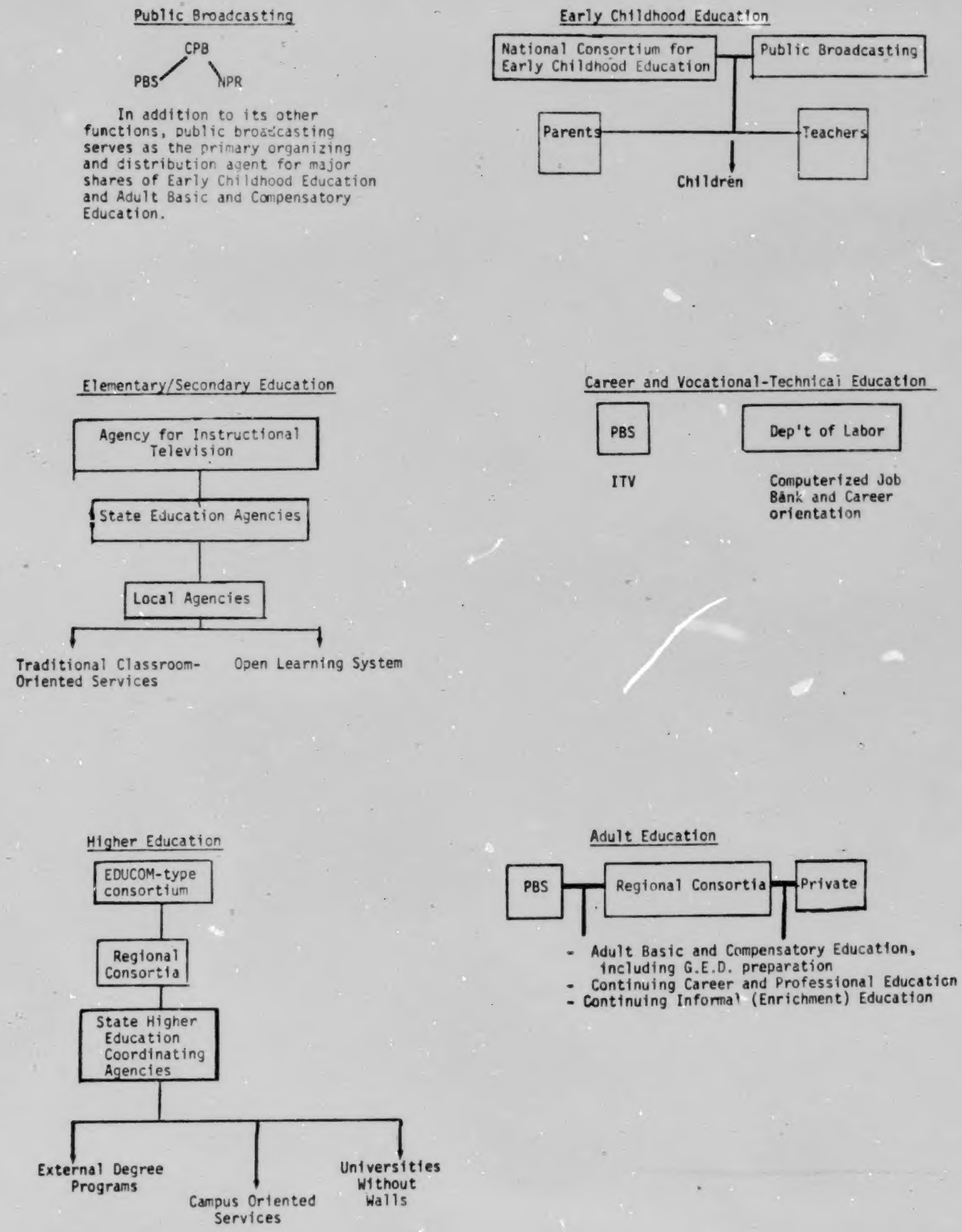
Each subsector has its own organizational/administrative arrangements for interfacing with the superstructure outlined on this chart.

Operated by satellite entity in the case of a dedicated satellite system, or by a consortium of education-sector users in the case of a non-dedicated satellite system. These centers would be either general-purpose centers serving assigned regions or specialized centers serving nationwide. They would be supplemented by centers organized and operated by each subsector.

State and Local User support agencies. Each subsector may have its own state and local coordinating agencies to tutor, provide classrooms, test and evaluate, etc.

FIGURE 10

Overall Organizational System Structure


Public Broadcasting
CPB
PBS
NPR
Early Childhood Education
National Consortium for Early Childhood Education
Public Broadcasting
Parents
Teachers
Children
Elementary/Secondary Education
Agency for Instructional Television
State Education Agencies
Local Agencies
Traditional Classroom-Oriented Services
Open Learning System
Career and Vocational-Technical Education
PBS
Dep't of Labor
ITV
Computerized Job Bank and Career orientation
Higher Education
EDUCOM-type consortium
Regional Consortia
State Higher Education Coordinating Agencies
External Degree Programs
Campus Oriented Services
Universities Without Walls
Adult Education
PBS
Regional Consortia
Private
- Adult Basic and Compensatory Education, including G.E.D. preparation
- Continuing Career and Professional Education
- Continuing Informal (Enrichment) Education

In addition to its other functions, public broadcasting serves as the primary organizing and distribution agent for major shares of Early Childhood Education and Adult Basic and Compensatory Education.

Figure 11

Possible Structural Arrangements for Various Educational Subsectors

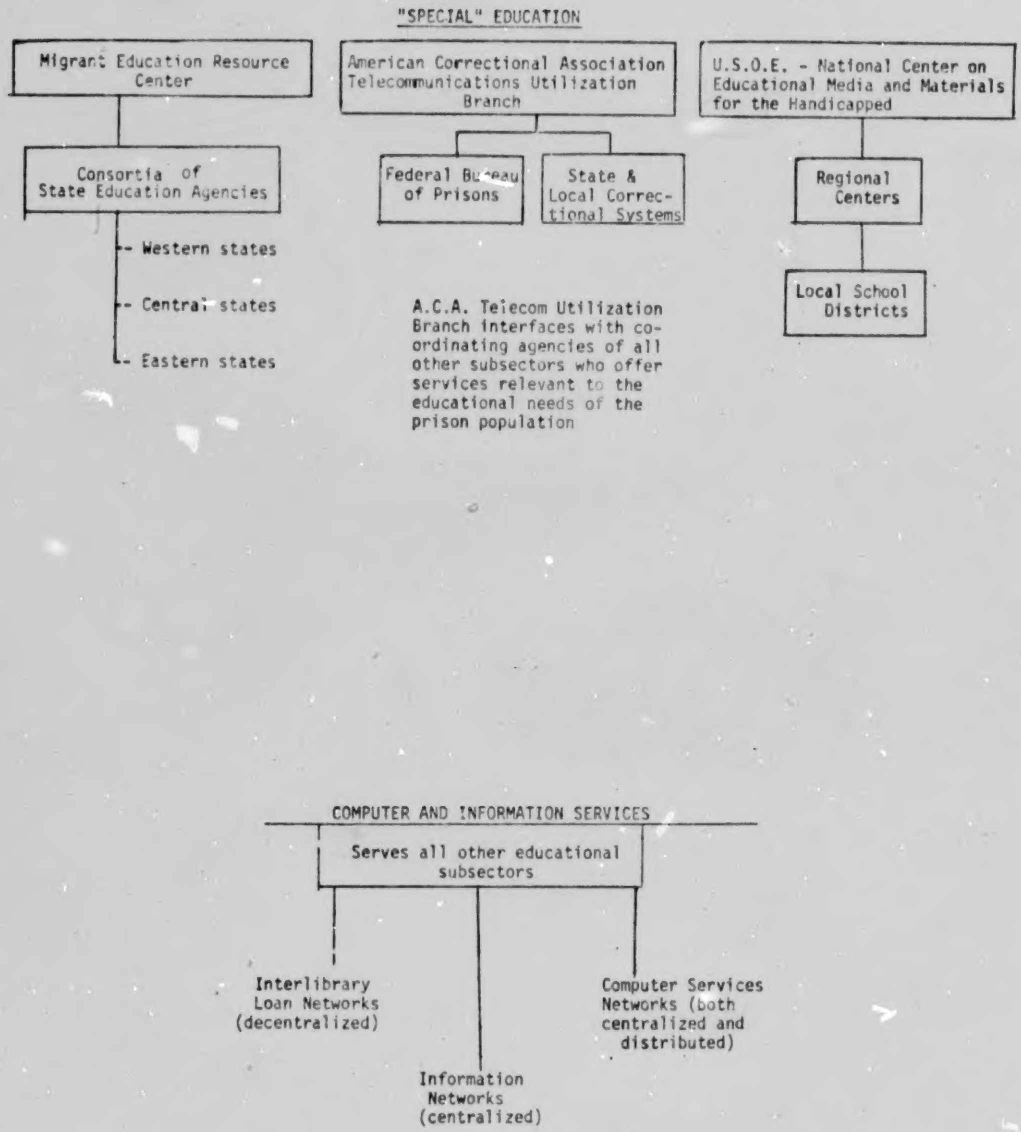

"SPECIAL" EDUCATION
Migrant Education Resource Center
Consortia of State Education Agencies
- Western states
- Central states
- Eastern states
American Correctional Association Telecommunications Utilization Branch
Federal Bureau of Prisons
State & Local Correctional Systems
A.C.A. Telecom Utilization Branch interfaces with coordinating agencies of all other subsectors who offer services relevant to the educational needs of the prison population
U.S.O.E. - National Center on Educational Media and Materials for the Handicapped
Regional Centers
Local School Districts
COMPUTER AND INFORMATION SERVICES
Serves all other educational subsectors
Interlibrary Loan Networks (decentralized)
Information Networks (centralized)
Computer Services Networks (both centralized and distributed)

Figure 11 (Continued)

Possible Structural Arrangements for Various Educational Subsectors

3. ALTERNATIVE ADMINISTRATIVE FRAMEWORKS FOR OWNERSHIP AND OPERATION OF THE SATELLITE COMPONENT

3.1 INTRODUCTION

This section describes four different hypothetical organizational arrangements for administering the satellite component of a large scale educational telecommunications system. The systems described include a system controlled by the Public Broadcasting Service (PBS), a system controlled by a non-profit consortium of user groups, a non-dedicated commercial system, and a publicly owned system designed to encourage pilot programs and eventual private sector takeover of educational satellite services. Together, these four hypothetical systems are intended to represent a spectrum of differing philosophies, strategies, and priorities with respect to educational telecommunications development.

In addition to describing the basic satellite organizations, this section will also include some discussion of the interface with users and terrestrial systems for redistribution of satellite signals. There will also be some consideration of the evolution of the various systems; that is, the events which might lead to their implementation.

Although the emphasis in this section is on administrative frameworks, the description of the satellite system controlled by the Public Broadcasting Service will include consideration of the channels and ground terminals that might be required to implement the basic concept represented by the system. The reason for including such requirements in the description of the public broadcasting controlled system ("Project Out-Reach") and not in the other descriptions is that "Project Out-Reach" is designed to implement a somewhat narrow category of service (i.e., extension of public broadcasting coverage), while the other systems are assumed to be for the purpose of implementing the broad spectrum of services for which channel and ground terminal requirements were described earlier in the market scenarios.

3.2 PROJECT OUT-REACH

As of November 1, 1971, about 28.5 percent of U.S. citizens were outside the Grade "A" coverage contour areas of the nation's 212 public television stations [9].* It has been estimated that extension of PBS coverage to include most of the people currently not served would require as many as 380 public broadcasting stations [9], or more than 100 more stations than are currently on the air. A report by the Carnegie Commission estimated this extension would require a capital outlay of $621 million; and a report by the Aspen Program on Communications and Society [9] estimates a requirement for $200 million in new annual funding for operation of new broadcast stations and repeaters. The estimates just mentioned are broadcast station-oriented and do not take into account the possible use of satellite to deliver public broadcast programming to unserved areas, which are mostly sparsely populated rural and remote areas in the Rocky Mountains, Plains states, Appalachian and Alaskan regions.

"Project Out-Reach" is a hypothetical program to deliver public broadcasting service to sparsely populated rural and remote areas. It is recommended as a first priority in the development of educational telecommunications service, partly because public broadcasting already has a software product to deliver and only lacks the communication channels through which to reach the unserved population. For many other educational sectors and services discussed previously, both software and distribution channels are lacking, as well as the organizational framework to coordinate the use of large scale telecommunications.

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*By early 1975, the number of public broadcasting stations had reached 248.

Although the top priority of Out-Reach is to extend service to rural areas, the program has a second major priority; namely, development of a second PBS channel for distribution of more regional programming, for distribution of programs to various redistribution/delay centers, and for delivery of certain instructional programming. The first two priorities are viewed as evolutionary steps that would eventually lead to a satellite system for serving the other major educational sectors discussed earlier.

Four key items need to be discussed with regard to "Project Out-Reach":

1. Who will operate the satellite system?
2. What are the channel and ground terminal requirements?
3. What are the requirements for implementing the 2nd priority, a 2nd public broadcasting channel?
4. How would the transition from a public broadcasting-oriented satellite system to a system serving multiple educational sectors be made?

3.2.1 Control of the Satellite System

It is envisioned that "Project Out-Reach" would be an effort coordinated by the Public Broadcasting Service and that the satellite system would be owned and operated by PBS, which was established to operate an interconnection system, inasmuch as CPB is forbidden by statute from doing so. The funding for the satellite system would come from Congressional appropriations to the Corporation for Public

Broadcasting, which will continue to finance interconnection activity by PBS and National Public Radio.

Since the system would initially be solely for delivery of PBS and regional public broadcast programming to rural areas, PBS is a logical candidate for control of the system. In addition to being served by the PBS national program service, each rural area will be able to receive the programs of regional and state public broadcasting networks in whose service areas they are located. Scheduling of channel time for use by state and regional public television networks will also be a PBS function.* Governance of PBS will continue to be structured as it is now, except that three representatives on the PBS board will be selected from among areas served by direct satellite-to-ground terminal service rather than station coverage.

3.2.2 Channel and Ground Terminal Requirements

The channel requirements for implementing "Project Out-Reach" would be based on the same distribution plans as discussed for public broadcasting in Section 2.2. Conceivably a satellite system for "Project Out-Reach" could fly within three years; so that channel requirements would be similar to those identified as near-term requirements. Those requirements, which assumed national, rather than multiple regional beams, include:

1. 2-4 full-time channels, which would accommodate the need for a three-hour West Coast time delay.
2. 58 channel hours/week available on a scheduled access basis.
3. 7 channel hours/week on an unpredictable need basis.

---

*The impact of the new CPB-PBS Station Program Cooperative on this arrangement has not been fully considered.

Since the "Project Out-Reach" satellite system might be the only satellite service available to public broadcasting,* the "scheduled access" and "unpredictable need" channel time would have to be accommodated within the channel capacity of the system. Therefore, we assume the requirement for channel capacity to be at the upper end of the 2-4 channel requirement estimated.

The second stage of development in "Project Out-Reach," involving a 2nd PBS channel, is assumed to require channel capacity equal to the long term requirements stated for public broadcasting in Section 2.2.2. There, an additional four full-time channels were estimated as the requirement. Therefore, by the time public broadcasting evolves into a 2-channel service, approximately 8 channels will be required. If it is assumed that 1/2 of that channel requirement is for national service, while 1/2 is for sub-national service, the requirement for 4 channels for regional service could be reduced to perhaps only one channel in a switched-beam configuration, since each channel could be used simultaneously for different programs in each beam area.

The requirement for ground terminals would depend on whether the satellite was to be used only for distribution to rural areas without public broadcast service or for the entire PBS interconnection system. Since it would seem wasteful to maintain both terrestrial and satellite interconnection systems, it is assumed here that the satellite system would serve both PBS station affiliates and ground terminals in areas without station service. Thus, the terrestrial distribution system currently used by PBS would no longer be utilized. Since PBS does not own these terrestrial facilities, there would be no problems concerning what to do with the old system.*

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*That is, it would not only extend service to rural areas but also substitute for the current terrestrial interconnection.

In addition to the 99 receive-only terminals and 28 receive-transmit terminals needed to serve PBS stations, there would be a requirement for approximately 12-15 thousand receive terminals located at viewing centers or community antenna headends in rural areas. Terminals would be leased or purchased from PBS by community television (cable-TV) organizations. The estimate of 12-15 thousand is based on U.S. Census Bureau figures indicating 13,706 places classified as rural in the U.S. It should be noted that some of those places probably do fall within the coverage areas of public television stations. At the same time, there are probably quite a number of places classified as urban (more than 2,500 residents) that do not receive public television service.

3.2.3 2nd Channel Public Broadcasting Service

Implementation of a 2nd channel would have to rely on cable television systems, since very few communities have more than one non-commercial television station. For rural areas without cable service, ground terminals could be located at special community centers. The number of additional channels required has already been estimated above as being included in the "long-term" PBS requirements.

Since ground terminals would already be in place for first stage extension of PBS service to rural areas, the only additional requirement would be for terminals at cable headends. Assuming 15,000 communities with cable service, the same number of receive-only ground terminals is required. This number if different than the cable headend requirements discussed in conjunction with the scenarios in Section 2.2. There, the requirement was for interactive terminals.

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*PBS is currently considering substituting a satellite interconnection for its terrestrial interconnection.

Cable headend interconnection by satellite had been planned previously by the Hughes domestic satellite entity (National Satellite Service, Inc) [52] and is being explored by a consortia of cable system operators.* PBS might either develop their own satellite system which interconnects cable systems or might lease channels from a commercial satellite-cable interconnection, should one come into being. In either case, one thing that could be required in the organizational framework of the 2nd stage "Project Out-Reach" would be an agent for procurement of cable television channels. It is anticipated here that this agent, a part of the PBS organization, would serve a function somewhat analogous to the advertising agency timebuyer, who selects television channels throughout the country for distribution of commercial messages to a preselected audience. It is also anticipated that the cable industry will develop a category of specialist whose job it will be to find "buyers" for leased access channels. Such specialists might represent a large number of independent cable systems, while multiple system operators (MSOs) would have time brokers on their own staffs. Figure 12 shows these different linkages for the primary "Project Out-Reach" service and the 2nd channel service.

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*A cable-satellite study has been performed by Booz-Allen Hamilton Corporation.

DISTRIBUTION OF PBS 1st AND 2nd CHANNEL SERVICES

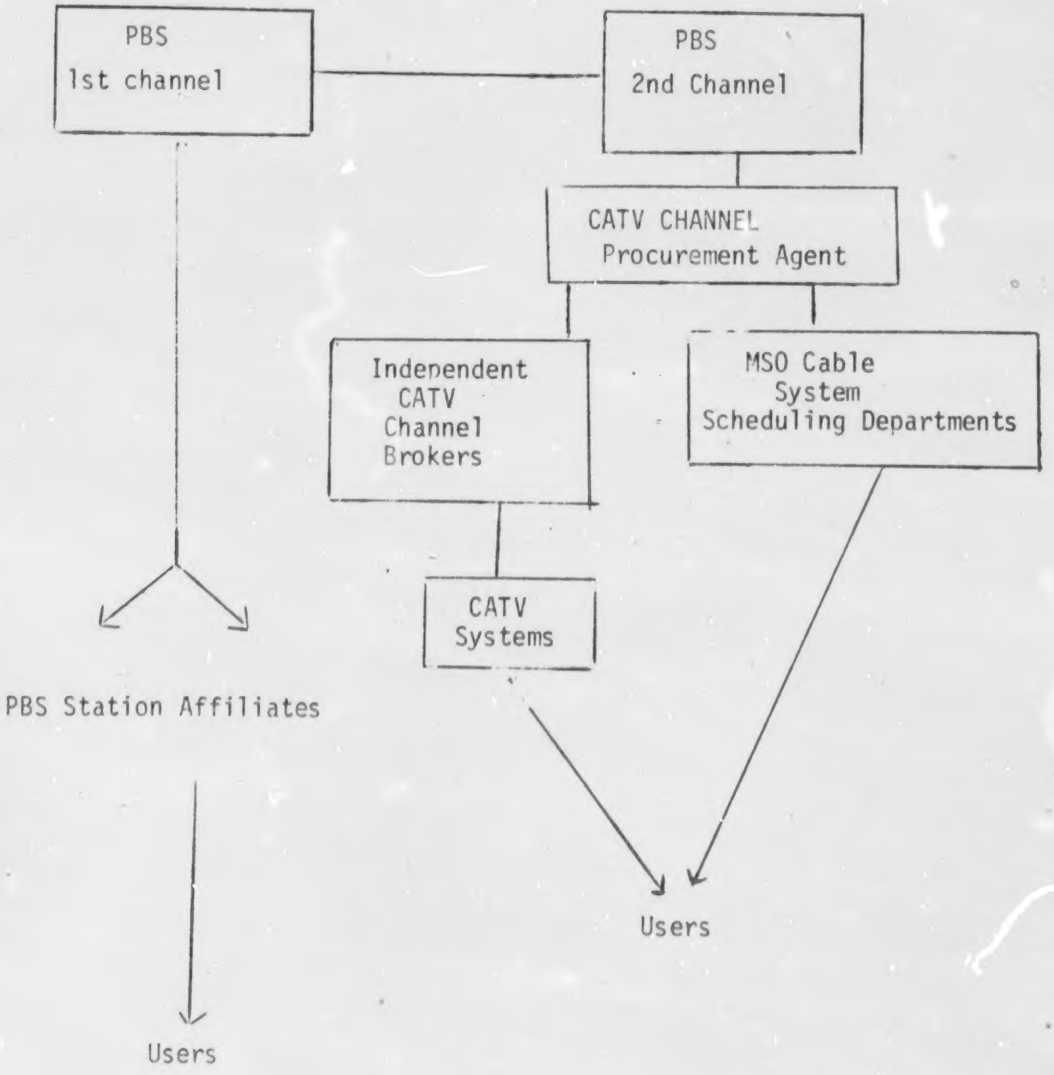

PBS
1st channel
PBS
2nd Channel
CATV CHANNEL
Procurement Agent
Independent
CATV
Channel
Brokers
MSO Cable
System
Scheduling Departments
CATV
Systems
PBS Station Affiliates
Users
Users

Figure 12

3.2.4 Transition to A PBS-Owned Satellite System Serving Multiple Educational Sectors

PBS leading the way with "Project Reach" may stimulate enough interest in educational applications of satellite technology that by about 1990, education may be ready for the broad spectrum of services envisioned in the scenarios considered in Section 3.2. If it becomes public policy to have PBS continue to operate the satellite system that will deliver educational services, then there should be some mechanism to insure that the needs and interests of educational sectors other than public broadcasting are adequately represented in governance of the satellite system.

To provide such a mechanism, legislation authorizing CPB to fund a PBS satellite service could provide that PBS should organize a panel of advisers representing various potential non-PBS users, i.e., the various educational sectors considered earlier. The legislation could further provide that, at such time as non-PBS users of the satellite system account for more than 20% of total hours of satellite channel usage, a separate board within PBS should be set up to govern the satellite system. Non-PBS sectors would be represented in approximate proportion to their usage of the satellite system. This way, as PBS begins to account proportionally for less and less satellite usage, the organization would gradually decrease its influence in governance of the system. Figure 13 illustrates the procedure. This transitional arrangement need not compromise PBS's control of its own system, since the adjustable membership representation only would apply to the satellite board; and PBS would still have access to the channels it requires.

EVOLUTION OF PROJECT "OUT-REACH" SATELLITE SYSTEM FROM PBS TO NON-PBS CONTROL

Phase 1

A separate board within PBS governs the satellite system but is made up entirely from members of the public broadcasting community.

Phase 2

Non-PBS educational sub-sectors begin to use the satellite system and are represented via membership on the Panel of Advisors. They have no decision-making power.

Phase 3

Non-PBS users account for 20% of total satellite usage and are given proportionate representation on the board of directors, with full voting privileges.

Phase 4

Non-PBS useage increases; PBS representation on board of directors gradually diminished to minority status.

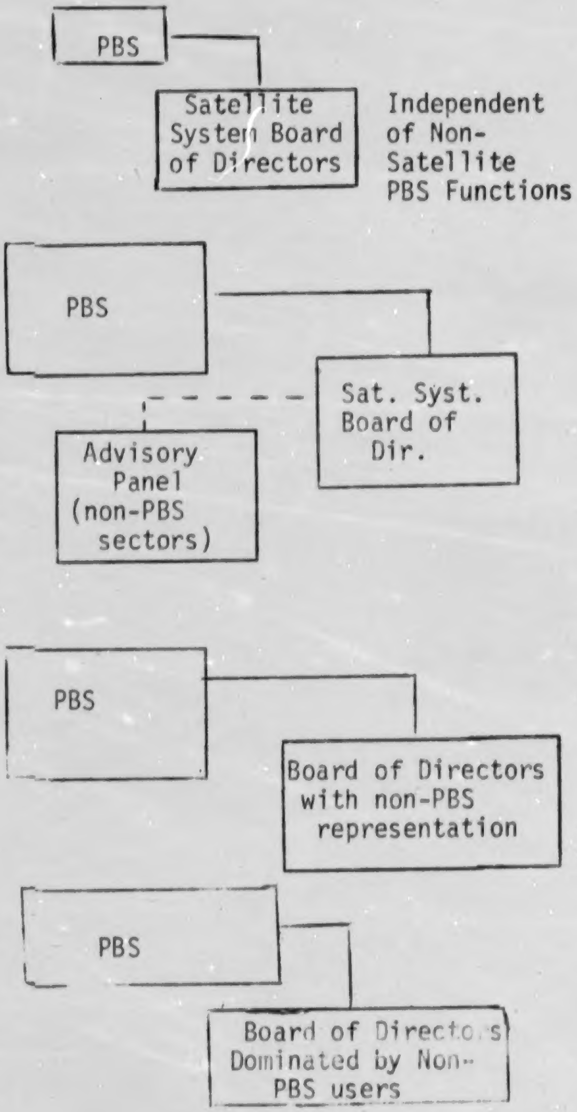

PBS
Satellite System Board of Directors
Independent of Non-Satellite PBS Functions
PBS
Sat. Syst. Board of Dir.
Advisory Panel (non-PBS sectors)
PBS
Board of Directors with non-PBS representation
PBS
Board of Directors Dominated by Non-PBS users

Figure 13

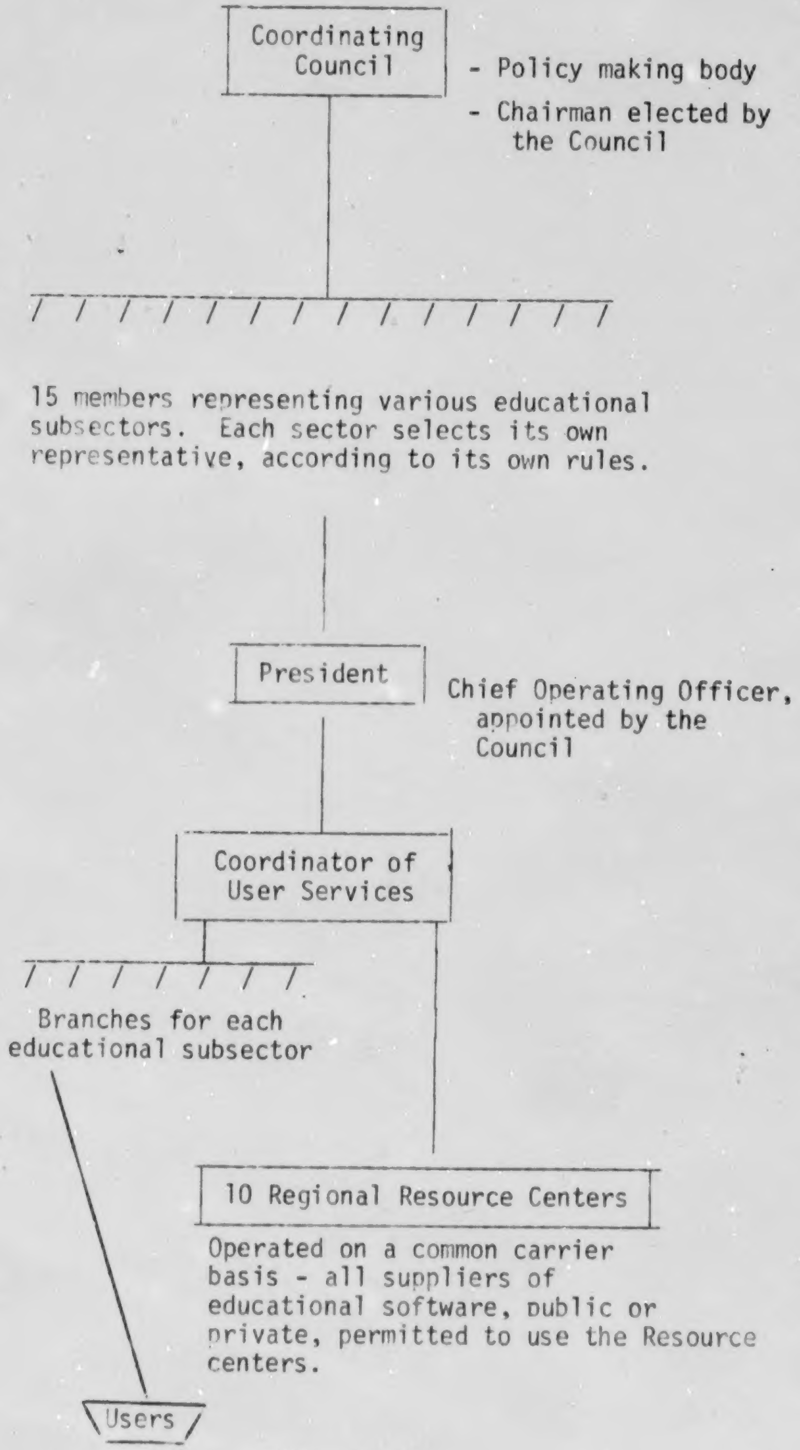
3.3 EDSAC

"EDSAC" stands for "Educational Satellite Consortium." Unlike "Project Out-Reach," which would be designed primarily to serve one segment of the potential educational telecommunications market and to meet one or two key objectives (extension of PBS coverage and expansion of PBS service), "EDSAC" is designed to serve the entire spectrum of potential educational telecommunications users.

The basic idea of "EDSAC" is a satellite system developed, owned and operated by a consortium of organizations representing major educational sectors in the telecommunications market. This user cooperative approach represents both a strategy for promoting effective delivery and utilization of educational satellite services and a philosophy concerning who should control a large service-producing organization, especially one which specializes in the processing of information and ideas. Further description of the administrative structure of EDSAC will help to define that strategy and basic philosophy. Briefly, EDSAC is based on the notion that a satellite system geared to the special needs of education can be most easily achieved by an organization whose reason for being is service rather than profit, that government influence over policies should be minimized and any possibility of the system being misused as a propaganda machine avoided, and that utilization of a service is most likely to come about if intended users have control of the system.

Figure 14 illustrates the portion of the EDSAC system which is entirely within the control of, rather than merely linked to the EDSAC organization. EDSAC is a non-profit corporation, entirely independent of supervision by any branch or agency of the government, except for regulatory matters affecting any telecommunications organization.

ORGANIZATION STRUCTURE OF EDSAC


Coordinating Council
President
Coordinator of User Services
10 Regional Resource Centers
Users

- Policy making body
- Chairman elected by the Council

15 members representing various educational subsectors. Each sector selects its own representative, according to its own rules.

Chief Operating Officer, appointed by the Council

Branches for each educational subsector

Operated on a common carrier basis - all suppliers of educational software, public or private, permitted to use the Resource centers.

Figure 14

At the top of the structure is the Coordinating Council, which is a policy making body. The council's 15 members represent different categories of educational telecommunications users designated in the EDSAC charter. Each organization designated in the by-laws as an authorized representative of an educational sector is entitled to select a council member. To provide each educational sector with maximum flexibility, the by-laws specify that each major sector, represented by an authorized organization, is entitled to select its council member by whatever manner it wishes and for whatever length of term it wishes. This procedure differs sharply with the procedure in a typical quasi-government organization such as CPB, where the board of directors is appointed by the President of the United States. Of course, the procedure also assumes various sectors to have organized themselves for the purpose of utilizing telecommunications. Whether that degree of organization can be achieved is debatable. However, if it cannot be achieved, there is some question as to the usefulness of an educational satellite system. The EDSAC procedure is designed intentionally to insulate the organization from any degree of government control. The Coordinating Council has a chairman, elected by the members.

The chief operating officer of EDSAC is the organization's President. One of the key management officials reporting to the President is a "Coordinator of User Services." Among the many functions performed by the coordinator's office is a traffic management (i.e., scheduling access to satellite channels). In connection with this function, the coordinator's office will have the ability to perform as an agent for procurement of non-satellite distribution channels, so that a user can arrange for end-to-end distribution by going through one office.

The coordinator's office is subdivided into several different divisions, each representing a major educational sector. A user from the higher education sector, for example, would channel requests for EDSAC service through the office designated to serve that sector.

A major responsibility of the Coordinator of User Services is operation of ten Regional Resource Centers located at points throughout the country. The EDSAC owned resource centers will be equipped with large computer facilities, television equipment and other hardware. They will serve as regional, general purpose centers, serving all educational subsectors for their assigned regions. They will function as the major software storage and satellite system entry points. A fundamental aspect of these centers is that they will be, according to the EDSAC charter, operated on a "common carrier" basis; i.e., any software supplier, public or private, will have access to the storage centers, which is tantamount to access to the satellite distribution system. The centers will be open to suppliers on a cost basis, so that the only criterion for acceptance or non-acceptance of software will be the supplier's ability and willingness to pay the cost of using the facilities. The drawbacks to making suppliers pay the cost of accommodating their materials have been discussed elsewhere [45]. There is a possibility of built-in discrimination against potentially beneficial software produced by suppliers who cannot afford to pay cost. Nevertheless, such an arrangement represents an alternative to determining access by fiat. The centers should be designed with large enough capacity to minimize the access problem. Of course, the criterion for whether or not the software actually gets distributed via satellite is whether or not there are buyers. Users, such a state-wide elementary school telecommunications network, would simply submit a request for materials through the office of the Coordinator of User Services, who would see to it that the software was retrieved from storage and that satellite channel time was reserved for distribution of the requested material.

The "common carrier" concept discussed here is very similar to that suggested by Dumolin and Morgan [14]. The rational behind the DuMolin-Morgan AVSIN plan was that a common carrier system would provide a competitive market place in the educational telecommunications software field and, thereby, insulate the software side of the system from undue government influence. The AVSIN system, like EDSAC, had two independent spheres of activity: (1) the administrative/hardware side and (2) the software production side. The administrative/hardware side is to be controlled by EDSAC, while the software production side is controlled in the open market. EDSAC differs organizationally from AVSIN in that the EDSAT organization itself is a user controlled and financed system, thereby providing further insulation from government control. AVSIN calls for a quasi-governmental satellite system financed directly by the government and governed by a presidentially-appointed board of directors. AVSIN relies primarily on the common-carrier aspect to prevent government influence. Although the extra protection afforded by the user-control aspect of EDSAC may be ideal, AVSIN may be a more realistic plan from the standpoint of organizational workability.

Another administrative function of the User Service Coordinator's office will be to maintain an on-line computerized catalog of all the materials and services available in the entire educational telecommunications system.

As noted previously, each major educational sector will be represented by a division within the User Services Coordinator's office.

These educational sector divisions will be staffed by full-time, paid employees of the EDSAC organization. The divisions will work with non-EDSAC telecommunications coordinators representing each educational sector. For example, a national early childhood education consortium might coordinate for that sector. The important thing is that each educational sector will have responsibility for organizing itself for telecommunications utilization in a manner which is most appropriate for that particular sector. The structure of this coordination effort might be quite different for a sector like elementary and secondary education than for higher education. An effort was made in Section 2 to speculate about what the utilization support structure might look like for the various educational sectors.

3.3.1 Funding for EDSAC

The physical plant for the EDSAC system will be substantial, including not only satellites but also ten major regional Resource Centers. In addition, the operating costs would require heavy funding.

Two of the objectives of the EDSAC organizational structure are to minimize government influence over policy and to give users maximum participation in decision making. These objectives will be met partly by the fact that EDSAC is a private organization, without the quasi-governmental status that the Corporation for Public Broadcasting has. The grass roots selection of members for the EDSAC coordinating council will also contribute. However, the management structure is not the only factor in achieving the objectives.

Whoever controls the system's financial lifeline is bound to influence policy, either directly or indirectly. A large degree of federal funding will be necessary to seed development of EDSAC and to finance year-to-year operations. However, the mechanism for distributing federal money will be a crucial factor affecting the government's influence over the system. If federal money is given directly to EDSAC, the potential for government influence is substantial. Therefore, the EDSAC system should be funded primarily by user groups. Federal funds for participation in educational satellite and telecommunications activity would be distributed directly to user groups, who would determine how to allocate the funded among satellite and smaller-scale telecommunications activity. To maintain a solid revenue base, EDSAC will have to satisfy users, rather than the government. Users will allocate a portion of their government financial assistance to the purchase of ground terminals, since the plans call for users rather than the EDSAC organization to own the terminals. Some educational sectors may structure their utilization support programs so that terminals will be purchased in mass quantity by cooperatives in order to get a lower per unit price.

The grass roots financing structure just outlined is similar in concept to the station program cooperative now in effect for public television, under which federal funds are allocated directly to public broadcasting stations, who will channel money upward to support PBS, thereby casting monetary votes to decide what programs will be included in the PBS schedule. [46]*

3.3.2 The Problem of Getting Started

The cooperative (or consortium) approach to funding, management and operation of a satellite system sounds good in principle but is easier

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*Such an arrangement may result in minority inputs and voices not being sufficiently well represented.

said than done. Once an organization is off the ground, it stands a better chance of survival if there is grass roots participation in management. But assembling unrelated segments of the educational market for the purpose of making the initial thrust that is necessary is a formidable task.

To an extent, the availability of federal funds for a specific purpose (such as an educational satellite system) can be a powerful force, driving previously unrelated elements together into a common effort. The ability of federal funds to serve that purpose is evidenced by the numerous computer and interlibrary networks that have been started with federal seed money. [36, 38]

Another possibility is that EDSAC will not start from scratch but will instead, evolve from the latter stages of "Project Out-Reach." "Project Out-Reach," as outlined earlier, calls for a mechanism by which an autonomous board within the PBS structure would be established for governing the satellite system whenever non-PBS users account for more than 20% of satellite usage. EDSAC would go just one step further by having the governing organization for the satellite system separate completely from the PBS organization. When the separation occurred, PBS would become just another user, albeit, an important one.

The strategy of gradual evolution of EDSAC from a PBS satellite system seems a more realistic possibility than any other strategy, since it does not require all educational sectors to be ready to begin utilizing satellites before a PBS system can get off the drawing boards.

3.3.3 Standardization

It is important that a comprehensive educational telecommunications system have some mechanism for promoting technical standardization for both hardware and software. It would be inconsistent with the "democratic" approach to management of EDSAC to legislate such standardization. Instead, users and producers of software and hardware must voluntarily come to the realization that, in the long run, it is in everybody's interest to arrive at some compatibility among systems. Currently, the Educational Products Information Exchange Institute exists to facilitate communications between user and producer regarding standards.[47] EDSAC should maintain close liaison with organizations such as EPIE and should seek to use its visibility and its status as a representative of a large segment of customers for educational telecommunications equipment as leverage for convincing producers to get together on standards.

3.4 SKYNET

SKYNET is a commercially owned and operated satellite system serving a large number of different users, of which the educational community would only be one. SKYNET differs from the domestic commercial satellite systems recently approved by the Federal Communications Commission, in that it is a high power satellite system capable of serving small, low-cost ground terminals.

The SKYNET concept is included here as one alternative for educational satellite services. Its two standout characteristics, commercial ownership and non-dedicated status, are worth considering for some very good reasons. First, the American economic system's bias toward leaving things to the private sector has been incorporated into domestic communications satellite policy, as reflected in NASA's decision to phase out its communication satellite R and D program. Second, in the absence of major federal government initiatives, a cooperative venture such as that envisioned for EDSAC seems highly unlikely. Third, potential and actual educational markets for satellite communications service are two different things; and the actual educational markets may not be sizeable enough to justify a dedicated satellite system of even minimum efficient size. However, combined commercial, educational and governmental traffic might potentially be dense enough to support a high-power satellite system.

There has been a good deal of discussion about potential educational applications of high power satellite technology, but education is not unique in its potential for cashing in on the benefits of a satellite system that can serve large numbers of low cost terminals. This capability could also serve law enforcement agencies, federal agencies and their branch offices around the country, stock brokerage firms and their branches, commercial computer time-sharing organizations, the banking industry, etc. One businessman is reportedly planning to construct Multipoint Distribution Service (MDS) systems in several major U.S. cities and to interconnect them via satellite. [48].

No high power satellite/small earth terminal configurations are scheduled for launch with the first generation of domestic commercial satellites scheduled for deployment during the early and mid-1970's. The question that arises with respect to the commercial satellite operators is, "Will they ever deploy high-power satellites?" Assuming the market for broadcast satellite service becomes more certain than it is now, their answer may very well be, "Yes...eventually!" There are a couple of likely developments on the horizon which might gradually lead to deployment of a high-power system when the second generation of domestic commercial satellites go up between 1980-1985.

First the cable television industry seems to be extremely interested in the use of satellites to interconnect cable headends.[44] If they decide to go ahead with a cable-satellite system, they could demonstrate in a dramatic way that there are markets which involve enough aggregated customers to justify the use of high power satellites. As cable operators move into interactive services, the demonstration could become even more dramatic.

Given a commercially owned and operated system such as SKYNET, an organizational effort would be required before the educational sector would be ready to utilize the system. A consortium of educational users would be established to assist in arranging for the procurement of time on satellite channels, to operate a network of Resource Centers and to maintain a catalog of software and services available to educational telecommunications users.

Like EDSAC, the Consortium in the SKYNET system will be governed by a council of members selected by authorized representatives of the various educational sectors.** One departure from the EDSAC system, however, is that Resource Centers, rather than being organized along regional lines, will be organized along lines of common educational interests. In effect, this would be a national distributed network of Resource Centers. The merits of this concept have been discussed elsewhere [45]. Essentially, this takes advantage of the fact that the cost of satellite communication is independent of distance and eliminates the necessity of storing every item in the national inventory at every center.

Another departure from the EDSAC system is that a more or less uniform hierarchy is assumed for utilization support. That is to say, instead of every educational sector having a different utilization support structure, [illegible] sectors would be served by a hierarchical system headed up by state educational telecommunications coordinators and filtering

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*See Figure 15.

ORGANIZATION STRUCTURE OF THE CONSORTIUM OF EDUCATION SECTOR SKYNET USERS

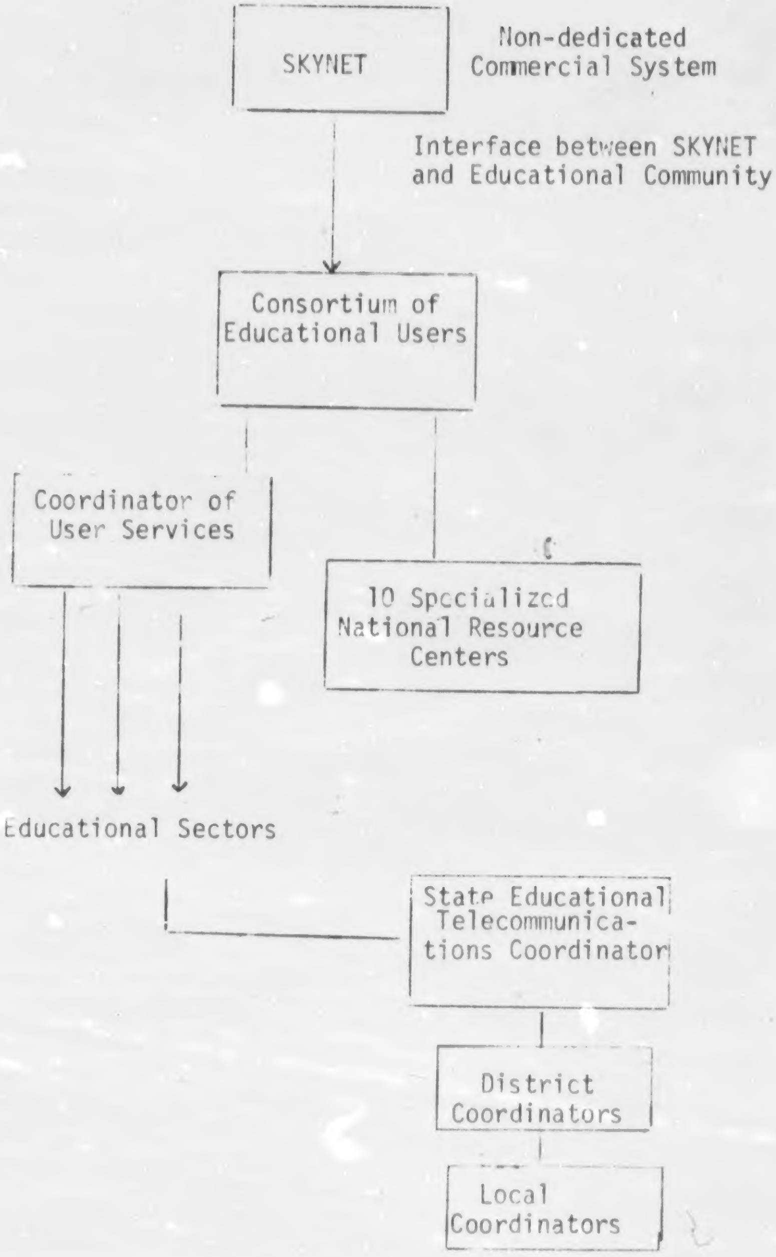
SKYNET
Non-dedicated Commercial System
Interface between SKYNET and Educational Community
Consortium of Educational Users
Coordinator of User Services
10 Specialized National Resource Centers
Educational Sectors
State Educational Telecommunications Coordinator
District Coordinators
Local Coordinators

Figure 15

down to intermediate district and local coordinators. Each sector would supplement this skeletal framework, as necessary, with supports of its own. For example, the higher education sector might have a network of regional cooperative learning-technology centers, such as suggested by the Carnegie Commission on Higher Education; and the Elementary and Secondary Education sector might have an Agency for Instructional Television to facilitate cooperative ITV production, although actual ITV materials produced would probably be stored at the National Resource Center for elementary and secondary education. Also, each sector would have to maintain its own system for handling the accreditation of services and certification of students, because the problems and requirements in this area are different for each sector.

3.4.1 Ownership of Terminals

In the EDSAC system, ground terminals other than the two-way uplinks at major resource centers are to be owned by users or cooperatives of users. The situation will be slightly different in the case of the commercial SKYNET organization. SKYNET will itself own and maintain a large number of interactive ground terminals for heavy users of SKYNET services. Low-cost receive-only terminals will be available for buy or lease from SKYNET. Being a for-profit organization, SKYNET will not voluntarily place more expensive interactive terminals at locations where traffic is too thin to cover the cost of the terminals. Users in these areas will be able to obtain interactive terminals from SKYNET or a competing supplier, but they will have to lease them and pay for a maintenance contract. The alternative is to enact legislation requiring SKYNET to provide "thin" users with the same ground terminal service as heavy users. However, the private sector is not likely to serve education at all unless there is a profit to be made. Any legislatively imposed service requirements are likely to lessen the probability of such service being provided unless they are subsidized or don't take away from the profitability of the rest of the system.

3.4.2 Role of Government

Since the satellite system itself is privately owned in the SKYNET system, the danger of government influence is somewhat reduced. However, the Federal government (HEW/NIE/OE) or, if the trend toward disbursing funds through revenue sharing continues, the state government will still need to play a large role in financing the development and operation of educational telecommunications services. It is recommended that governmental financial assistance be distributed in the same way as was recommended for EDSAC. Money would be distributed directly to users to channel back up to the national consortium or retained for use in local telecommunications services. The determination concerning what proportion should be distributed upward would be made partly on the basis of how responsive the national consortium is to the needs of the users.

3.5 PILOT

The organizational framework described here, PILOT*, represents an attempt to overcome the chicken-and-egg problem in development of educational satellite service. In a sense, it is a compromise between the EDSAC and SKYNET concepts.

EDSAC, a cooperative venture initiated by potential users, faces the difficulty of getting the educational community to organize itself for utilization of an unseen product. Education's track record in preparing itself for such innovations is not very encouraging. [13] On the other hand, it may not be very realistic to expect that the private sector will come through with a system like SKYNET, unless there is a fairly well-organized market waiting for such a system. This problem will be even more critical if the commercial and other non-educational markets for high power satellite service prove less promising than was assumed in describing the SKYNET concept.

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*Programs for Innovations in Learning with Orbiting Technology.

The basic purpose of PILOT is to break through this impasse with bold public intervention. Under the PILOT program, the government would seek to encourage private enterprise development of educational satellite services by providing a mechanism through which the private sector could seek out and test educational markets for satellite service without having to assume the major financial risk involved with deploying a satellite system.

PILOT would be a satellite system owned by a government corporation similar to the Tennessee Valley Authority. Another comparison that can be made between TVA and PILOT, besides public ownership, is that PILOT would not retail satellite services directly to educational telecommunications users but would wholesale channels or blocks of channel time to private sector telecommunications companies who might be likely candidates for eventual ownership and operation of high power satellite systems. TVA also wholesales rather than retails electric power.

A contrast with TVA is that the PILOT system would be established for a limited lifetime of 5-7 years, at the end of which private enterprise will be prepared to assume responsibility for providing high power satellite service to education. A number of examples of the U.S.

government developing new services and then turning them over to private enterprise can be cited in the fields of transportation and communications. Among them are the telegraph, air mail, and inland waterways shipping on the Mississippi River. [45]

The rationale behind such a strategy is that most economic activity should be handled by the private sector but that the public sector needs to get things off the ground far enough so that economic viability can be demonstrated to cautious private sector investors. However, PILOT is somewhat different, in that it relies on the private sector to develop and market satellite services for education. By providing satellite channels to the private sector at zero or small cost, PILOT provides an incentive for private telecommunications organizations to enter the field.

Although the private operators would be receiving an enormous public subsidy, they would be charging educational users for satellite service. In fact, a major element in the PILOT concept is for the private sector to deliver services in an environment approaching realistic market conditions. This is not only to demonstrate to the private sector that the educational community might be willing to pay for satellite service. It is also intended to serve as a mechanism for separating out worthwhile from marginally useful services, as determined by the marketplace. Demonstrations such as ATS-6 and CTS should be very useful. However, one thing the demonstrations will not accomplish is testing of services under the market conditions they must ultimately face.

Figure 16 shows the basic structure for the PILOT program. As with most government corporations, the governing board is appointed by the President of the United States. The chief operating officer, the president, is responsible for carrying out policies set by law and by the Board of Directors.

ORGANIZATION FRAMEWORK FOR PILOT

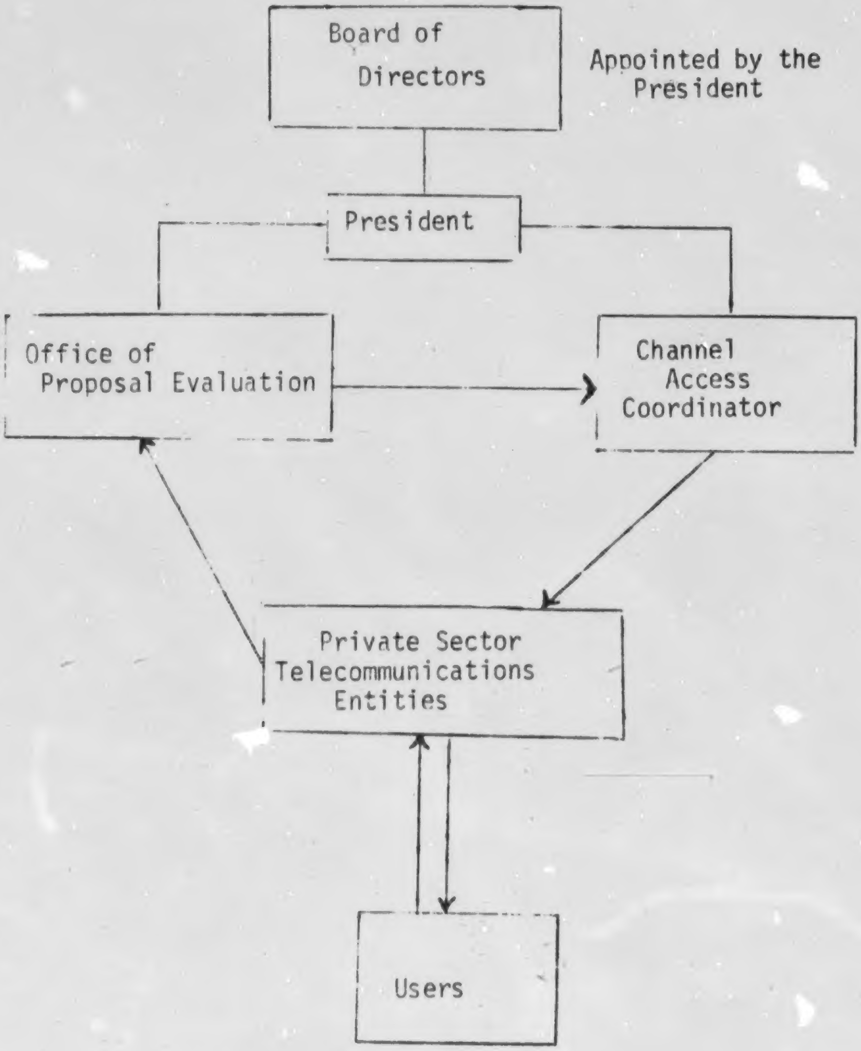
Board of Directors
Appointed by the President
President
Office of Proposal Evaluation
Channel Access Coordinator
Private Sector Telecommunications Entities
Users

Figure 16

One division within the organization is the Office of Proposal Evaluation. This division will insure that the uses to which private telecommunications companies put PILOT channels will be consistent with the objective of developing innovative educational applications of satellite technology. In evaluating proposals put forth by the telecommunications companies, the office of evaulation will want to apply a number of criteria, including:

1. Extent to which the project will make use of the unique capabilities of satellite technology.
2. Educational "soundness" of the proposal, including plans for assessing the educational results of the proposed program as well as its market success.
3. Plans for carrying on the proposed program after the initial test.
4. Plans for marketing the services to the intended educational users, including stimulation of cooperative initiatives within the educational community.

As shown in Figure 16, once the Office of Proposal Evaluation has approved a company's proposal, the matter is turned over to the operational side of the organization, where a channel coordination division arranges for satellite channels. The functions of the Office of Proposal Evaluation assign considerable power to that office to influence the shape of educational telecommunications development. An alternative would be to take all comers on a first come, first serve basis. In the EDSAC and SKYNET organizations, there were offices for arranging end-to-end distribution, including cable channels. PILOT will be different, in that the private telecommunications company will be left with the responsibility for making non-satellite distribution arrangements. By the time the PILOT system flies, a system for brokering CATV lease access channels such as described in connection with "Project Out-Reach," should be functioning.

3.5.1 Ground Terminals

One of the advantages of the PILOT approach to the development of educational satellite service is that it brings a number of different telecommunications organizations into the act. Hopefully, this will generate a diversity of approaches to marketing educational satellite services. Some companies might seek to serve a number of different educational sectors while others may concentrate on one sector. If the F.C.C. will permit, there could be a variety of tariff schedules, to see how users will react under different pricing situations.

One question that is unresolved is how best to market ground terminals. Should users buy them, lease them from the satellite operator or procure them from competing suppliers? Or perhaps the satellite operator will have greater success marketing services if the ground terminals are provided free. With a diversity of potential high power satellite companies participating in the PILOT program, there is an opportunity to test a diversity of ways of handling ground terminals. Therefore, it is recommended that ground terminals not be provided to users by the PILOT corporation itself.

3.5.2 Financing

In the beginning, it is recommended that the PILOT corporation subsidize the telecommunications companies by leasing them channels at little or no cost This will enable the companies, in turn, to charge less to the educational users. However, it is also recommended that the charge to the companies be gradually increased to cover the full cost and that the companies, in turn, increase their prices to a level that would have to be charged in an unsubsidized system. This way, a gradual build-up to testing under realistic market conditions can occur.

It will probably always be necessary to have a program of financial aid to education to enable the sector to utilize satellites. However, this aid will come from the Office of Education, not from PILOT. Furthermore, the aid should be in the form of direct aid to the users rather than to an educational telecommunications superagency. This may be the best way of making the suppliers of educational telecommunications services responsive to the needs of users.

3.6 CONCLUSIONS

Four very different alternatives have been discussed here: Project Out-Reach, devoted to extending PBS coverage and expanding PBS services; EDSAC, a cooperative of users; SKYNET, a multi-purpose commercial system; and PILOT, a government demonstration program designed to phase itself out by encouraging the private sector to assume responsibility, and structured to test services under market conditions.

Of the four, Project Out-Reach might enable PBS to reduce its interconnection costs, as well as enable people in rural areas to benefit from a service for which they already contribute tax dollars. In addition, Project Out-Reach would provide a logical first step for later development of the kinds of non-PBS satellite services that were discussed in Section 2.2

If Project Out-Reach is an alternative which seems worthy of immediate attention, PILOT seems to be the boldest approach to stimulating the dormant private sector to become involved in the development of long-range educational satellite services. The cooperative approach of EDSAC may be the most promising way of governing an educational satellite system so that it is free from federal interference. However, some of its features could prove to be very clumsy to deal with, in trying to get a system started. SKYNET is realistic if the non-educational side of the high power satellite service market exists and if educational users will find it to be of interest. Otherwise, something on the order of PILOT will be needed to convince the private sector of the viability of serving education. Clearly, more analysis of these and other alternatives is required.

4. CONCLUDING REMARKS

This memorandum represents an attempt to do two things. The first objective was to provide a basis for arriving at an estimate of the potential demand for future educational satellite services. One cannot overemphasize the fact that the scenarios from which these estimates were drawn could be 180 degrees wrong. Actually, future demand may be far less or far greater than this memorandum indicates. It is hoped that this memorandum at least provides a starting point for estimating both demand and cost.

The second objective of this memorandum was to present some alternative organizational approaches to educational telecommunications development. The alternatives which have been presented by no means cover the entire range of options, but they do reflect widely varying philosophies about the proper roles of the public and private sectors, as well as different strategies for getting the job done.

At the time this memorandum was prepared, the "Out-Reach" option seemed the most realistic because of the fact that PBS has already defined its satellite interconnection requirements and because the public broadcasting sector was probably the single telecommunications organization, national in scope, with the potential resources required to implement such a system. On the other hand, EDSAC seemed more idealistic than realistic -- idealistic in that it reflects the notion that an organization which begins at the grass roots and which is designed by those it is intended to serve will be more responsive to the needs of users. EDSAC did not seem realistic to us at first because of serious doubts that users could ever gather enough cooperative steam to get things rolling without considerable stimulation from some source such as the federal government. However, before this memorandum was completed, a Public Service Satellite Consortium, somewhat similar in structure to EDSAC has already been formed. In view of this development, one can perhaps be less skeptical about the ability of the educational sector to organize itself for the future.

Nevertheless, satellites are not cheap. Ground terminals and software could prove to be even more expensive than the satellites. Therefore, some form of financial contribution from the public sector seems essential. A renewed respect for the "market mechanism" seems to have surfaced among policy makers in the past few years. But it is well to bear in mind that the market only reflects demand, which depends in part on ability to pay. It does not always reflect need. A true picture of the need for educational satellite service can be had only if the educational sector is given the financial ability to choose among options, including whether or not to allocate funds for satellite development. Whether public assistance should be in the form of a PILOT-type project or in conjunction with a private sector initiative such as SKYNET remains to be determined.

There are even more basic questions to be considered through. Cost analyses remain to be performed for one thing. Hopefully, costing can be applied to the satellite and ground terminal requirements which have been spelled out in this memorandum and to other alternative requirements which may be developed. It should be pointed out that our requirements are likely to be more costly than others which may be developed because of the heavy emphasis on two-way terminals and because we have tried to illuminate a broad range of opportunities for high-power sattellite utilization in education. The approach being taken by the

Office of Telecommunications Policy of HEW appears to be somewhat more conservative and more attuned to economic reality [56, 57, 58]. There are other cost figures to be determined too, such as the cost of software and cost of local distribution from satellite reception terminal to end user via cable or other means. CAI requirements may have been underestimated and require reexamination in view of work in progress by Morley and Eastwood at our Center.

Even more important is the fundamental question of whether or not we should even have an educational telecommunications system of national scope, at any financial cost. Such a development is sure to be fraught with unintended educational, political and social consequences, both good and bad, some unforseeable even with the most extensive cost/benefit analyses and impact assessment.* Will information and computer networks lead to abuses? What safeguards can be constructed to prevent potential abuses such as violations of privacy? Can local and state educational prerogatives really be retained? What kind of a human product will our educational system turn out if the element of classroom socialization is diminished because of increased media usage? Is there a chance that one segment of society will receive a "mediated" education while another segment will be exposed to an entirely different set of educational experiences? If so, what are the societal implications of such a double tier educational system? Will minority interests be sufficiently well represented? These and many other questions deserve much more attention than they have received to date.

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*A paper by Morgan has identified potential impacts of large-scale educational telecommunications systems. [55]

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